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BULLETIN NO. 151

SOME IMPORTANT INSECTS OF ILLINOIS
SHADE TREES AND SHRUBS

By STEPHEN A. FORBES
STATE ENTOMOLOGIST



URBANA, ILLINOIS, OCTOBER, 1911

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SOME IMPORTANT INSECTS OF ILLINOIS SHADE TREES AND SHRUBS

BY STEPHEN A. FORBES, STATE ENTOMOLOGIST

The protection of the shade trees and ornamental shrubs of Illinois against insects has been for several years a problem of rapidly increasing importance. Many of our most desirable trees and shrubs are liable to slow destruction by obscure insect pests understood little if at all by those immediately concerned. Trees which have grown for years, becoming more attractive, more valuable, and more highly valued year by year, begin to weaken and decay, the owner does not know why. This is often due to borers or to scale insects, the presence of which has not been detected or suspected, but whose injuries might have been prevented if the facts had been known in time. More sudden losses are frequently caused by overwhelming attacks of leaf-eating insects which, altho conspicuous, are not dealt with because proper measures of procedure are not known. Observations and experiments upon this subject have been for several years a prominent part of the work of the office. Beginning in 1898, repeated careful examinations have been made of the trees and shrubs of the parks and boulevards of Chicago, and this work has been extended from time to time to other cities and towns thruout the state. With the establishment of a field assistant in Chicago in 1907, the subject received more continuous attention at the hands, first, of Mr. H. E. Hodgkiss and, later, of Mr. John J. Davis, the latter of whom especially has made many studies of the life histories of species previously but little known, and has added a mass of details to our knowledge of the subject in all its parts.

The general subject is still under investigation, and will be in due time reported upon in a much fuller and more elaborate article, but the present brief preliminary paper has been prepared in the hope that it may be found of immediate practical use to municipal authorities in control of parks, boulevards, and streets, to town improvement societies, and to owners of lawns and other private premises the appearance of which they are striving to improve by the use of trees and shrubs.

THE CATALPA SPHINX

(*Ceratomia catalpæ* Bdv.)

One of the most destructive of the few insects to which the catalpa tree is subject is a large showy caterpillar known as the catalpa sphinx (Fig. 1). It is a southern insect, and has not been found in this state north of Clay and Richland counties, altho it has



FIG. 1. Catalpa Sphinx (*Ceratomia catalpæ*): a, egg mass; b, newly hatched larvæ; c, d, larvæ one-third grown and one joint showing its dorsal pattern; e, f, g, h, i, mature larvæ, variously marked, and single joints showing dorsal patterns; j, pupa; k, moth; l, egg, enlarged; others all slightly less than natural size. (Ohio Experiment Station.)

extended up the Atlantic coast as far as New Jersey. It is likely to appear suddenly in large numbers upon single trees, stripping them completely.

The full-grown caterpillar (Fig. 1, *e*, *f*, *h*) is rather strongly marked, with a broad velvety black stripe on the back and sulphur-yellow sides spotted with black, while the under side of the body is pale green. It is unusually variable in color, however, there being both light and dark forms. It is from two and a fourth to three inches long, and has a hornlike appendage projecting from the hinder end of the back. The young caterpillars (Fig. 1, *c*) are pale yellow and spotted with black. There are probably but two generations in Illinois. The caterpillars leave the trees and go into the ground to pupate (Fig. 2).



Fig. 2. Catalpa Sphinx, *Ceratonia catalpæ*, pupa in cell in earth.

The parent insect is a large heavy-bodied moth (Fig. 1, *k*) with strong, narrow, brownish-gray wings, with obscure lines and spots of black. The eggs (Fig. 1, *a*) are laid in masses on the leaves, sometimes as many as a thousand in a bunch, and the young, on hatching, feed at first in companies—a fact which makes it easy to destroy them if their presence is detected early, by picking off or spraying the infested leaves. A general spraying of a tree with arsenate of lead or Paris green will destroy the caterpillars at any time. Professor H. Garman, of Kentucky, says that the nearly grown worms can be shaken or jarred down from most catalpa trees and readily destroyed by hand.

THE FALL WEB-WORM
(*Hyphantria textor* Harris)

The fall web-worm is the only common Illinois insect which makes a large conspicuous web in late summer and in fall, inclosing a considerable number of the leaves and twigs of a branch, together



Fig. 3. Fall Web-worms, *Hyphantria textor*, and their web, on apple-tree.
(New Hampshire Experiment Station.)

with a colony of caterpillars which feed under its protection (Fig. 3). It is unfortunately often called in Illinois the tent caterpillar, but the latter name is properly applied only to a caterpillar, not often seen in this state, which makes a small compact web in the forks of a branch in spring, which it uses only for protection while not eating.

The web-worm is an almost universal feeder and has been found on about a hundred and twenty species of fruit, shade, and ornamental trees, upon the leaves of which it feeds. It is one of the most annoying pests of the tree grower, its numerous large webs, enclosing brown, skeletonized leaves, making the tree very unsightly, and the injury done, as it spreads from branch to branch, often being considerable. While the caterpillars are growing they do not wander from their common web, but enlarge this to cover fresh leaves as fast as those within it are devoured. When they have nearly completed their growth, however, they scatter far and wide, running briskly about when disturbed, and feeding on almost

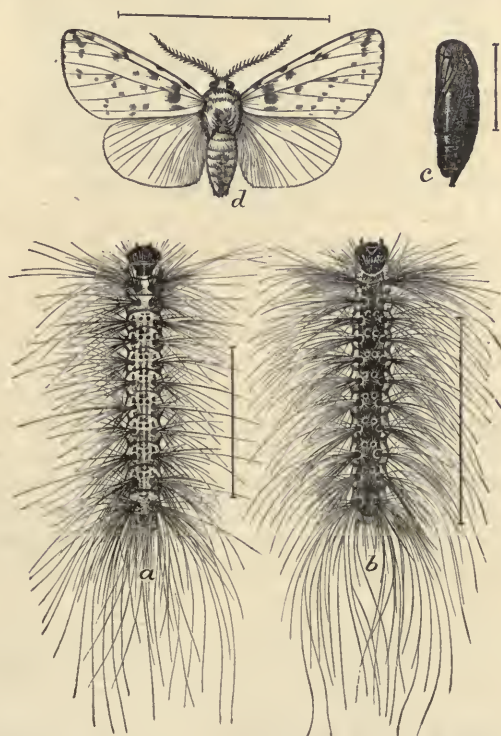


Fig. 4. Fall Web-worm, *Hyphantria textor*: a, b, larvæ, light and dark varieties; c, pupa; d, moth, spotted variety. All slightly enlarged. (New Hampshire Experiment Station.)

every green thing they find. At this time they become, when very abundant, an extremely destructive and annoying pest.

They are about an inch long when full grown, varying from pale yellow or grayish to a dark bluish-black hue. (Fig. 4, *a, b*.) The body is covered with long straight hairs grouped in tufts rising from small black or orange-yellow tubercles, of which there are a number on each segment. When mature, the caterpillars go to the ground, into which they burrow a short distance, or they creep under shelter above ground, where they form slight cocoons of silken web interwoven with the hairs from their bodies. Within these they change to dark brown pupæ (Fig. 4, *c*), and in this condition they pass the winter. The moths emerge in spring and lay their eggs in broad patches of several hundred each, on the under side of the leaves near the end of a branch, late in May and early in June. The adult insect is usually pure white, but is sometimes white spotted with black. There are either one or two broods of this species, according to the latitude, two in southern and central Illinois and probably but one in the northern part of the state.

The simplest and most effective method of controlling these insects is to destroy their webs, and the caterpillars within them, either by cutting off the twigs which bear them and crushing or burning them immediately, or by burning the webs on the tree. A bundle of rags or a few corn-cobs, or even a porous brick, wired to the end of a pole long enough to reach the nest and saturated with kerosene, makes a good torch for the purpose. Care must be taken, however, not to injure the tree, and to destroy the scattering worms which may drop from the nest without being killed. Where the infestation is too general to make this method convenient, or where the webs are so high in the trees that they can not be readily reached, a spray of arsenate of lead will eventually kill the web-worms as they extend their webs over the poisoned foliage. Paris green may be used instead, but the lead arsenate is to be preferred because, being much more adhesive, it lasts longer on the tree. This method is most effective when the caterpillars are young, since they are then extending their webs rapidly and are likely to be more promptly poisoned than when they are virtually full grown.

THE YELLOW POPLAR-CATERPILLAR

(*Apatela populi* Riley)

The prominence of the Carolina poplar as a city tree, especially in situations where it is difficult to find any other which can endure the conditions prevailing, makes it the duty of the Entomologist to discuss the insect enemies of even this rather inferior variety.

Among those which have recently been found most injurious to the poplar is a large and rather handsome, light yellow or pale green, very hairy caterpillar (Fig. 5), most easily known by five long pencil-like tufts of black hairs rising one behind the other on the middle line of the back, the first on the fourth segment of the body and the fifth on the last. This caterpillar was particularly injurious to poplars and considerably so to willows in Chicago in 1909. It has been noticed by us also in Peoria, Danville, and East St. Louis. It feeds on the leaves in midsummer and again in fall, there being two generations in a year. It sometimes completely



Fig. 5. The Yellow Poplar-Caterpillar, *Apatela populi*, natural size.

strips a tree, rendering it unsightly and putting it in poor condition to withstand unfavorable conditions or to resist the attacks of more destructive insects.

The caterpillar when full grown is about an inch and a half long, the skin yellowish-green, and the long, soft, drooping hairs yellow. The pencil-like tufts referred to rise from the fourth, sixth, seventh, and eleventh segments, those on the seventh and eighth being the smallest. The head is shining black and there are black spots on the top of segments one and two. The young are almost white, and the black tufts of hairs are shorter, but still conspicuous. The caterpillar is of a sluggish habit, and when at rest it commonly lies curled up, with the ends of the body together. When full grown it spins a loose, pale yellow cocoon of silk interwoven with its own hairs. This is generally placed in a crevice of the bark, under the edge of a fence board, or in some similar sheltered place. The winter is passed in this chrysalis stage, from which a large, pale gray moth emerges the following May.

The caterpillars are most easily destroyed when young, for they do not at first scatter from the branch upon which they were born.

Later they can readily be collected singly by hand from trees of small size, or they may be poisoned, like most of the leaf feeders, by spraying with arsenicals when they are active on the tree.

THE WALNUT CATERPILLAR

(*Datana integerrima* G. & R.)

The most annoying insect enemy of the walnut is a blackish, somewhat striped, hairy caterpillar (Fig. 6), an inch and a half long when full grown, which eats the leaves during the latter part of the summer, often largely denuding the tree. It makes itself particularly offensive on lawns by dropping quantities of refuse from the tree and by crawling over walks and buildings when it comes down to go into the ground.

This caterpillar is readily distinguished by its loose coat of soft whitish hairs, and particularly by its habit of raising both ends of the body when at rest and throwing itself into this position and jerking sidewise when disturbed. It often attracts attention by collecting in masses upon the larger branches or the trunk of the tree preliminary to molting, piling up in this way two or three layers deep. When full grown it comes down the trunk to the ground, wanders about to a short distance and enters the earth an inch or two, changing there to a reddish-brown or blackish-brown chrysalis (Fig. 6, B). In this stage it winters, emerging the following summer, mainly in June and July, in the form of a buff-brown moth (Fig. 6, A) with darker bands across the fore wings. The females lay their eggs in clusters varying from seventy-five to a hundred, according to some observers, and from five hundred to twelve hundred, according to others, and the young hatching from these feed in dense clusters, completely devouring every leaf as they go. When all the leaves on one twig or branch are destroyed, they migrate to another, sometimes in a distant part of the tree. They lose their gregarious habit as they mature, and by the time they are full grown they scatter here and there over the greater part of the tree. There is but a single generation in a year.

Altho they are most frequently seen on the walnut, they are common on butternuts and hickories, and are a pest to the grower of the pecan. They have likewise been found on beech, oak, willow, honey-locust, apple, and thorn. Trees in the forest are not likely to suffer, but those on streets and lawns are sometimes so completely stripped by September that they stand almost as naked as in mid-winter, only the green nuts remaining on the branches.

This account of their habits is sufficient to suggest various available methods of destroying them. On trees small enough to be reached they can be readily killed while young by clipping off the

infested twigs on which the caterpillars are grouped in colonies. They are particularly exposed to attack as they assemble in masses for their later molts, when a light spray of kerosene will readily kill them. They are also susceptible to arsenical poisons sprayed



Fig. 6. Walnut Caterpillar, *Datana integerrima*: A, moth; B, pupæ. Natural size. (Kentucky Experiment Station.)

upon the leaves, but these must be used in unusual strength. We have found three pounds of arsenate of lead to fifty gallons of water sufficient to kill the full-grown caterpillars. On one occasion a tree nearly fifty feet high was effectively sprayed by the aid of a twenty-eight-foot ladder and a twelve-foot extension rod with a nozzle on the end, about twenty-five gallons of the spray being necessary for a thoro treatment. If these various measures have been neglected and the caterpillars have left the tree, they may still be disposed of in the pupa stage by digging up and working over the ground under the branches and for a little distance outside, to a depth of three or four inches.

THE WHITE-MARKED TUSSOCK-MOTH

(*Hemerocampa leucostigma* S. & A.)

The most destructive leaf-eater infesting shade trees in the larger cities of Illinois and especially in Chicago is the caterpillar of the white-marked tussock-moth. It often completely defoliates large trees, those most seriously injured being the elm, the soft maple, the linden, the birch, and the horse-chestnut. (Fig. 7.) Almost every kind of tree, excepting conifers, is subject to its attack, and it sometimes becomes decidedly injurious in orchards. In Chicago it has been noted as injurious to apple, box-elder, hard maple, Norway maple, poplar, willow, oak, ash, locust, hickory, catalpa, and sycamore, and to several shrubs, including dogwood, button-bush, *Viburnum*, and bladdernut (*Ptelea*). In September and October, 1910, it was found in every one of eighteen towns visited by Mr. John J. Davis, present in small numbers in seven of them, common in nine, and in destructive numbers in two.

This is a well-marked insect, very easily recognized, especially the caterpillar and the egg mass—the two conditions against which measures of destruction must be taken. The hairy caterpillar (Fig. 8), bright yellow in general color and striped with black, and about an inch and a half long when full grown, is a really beautiful object. It may be known by its coral-red head, by two plumelike tufts of long black hairs projecting upward and forward from the back near the head, by a single similar tuft at the hind end of the body, and especially by four thick, short, brushlike clusters of cream-colored hairs arranged, one behind the other, in front of the center of the back. In this condition it may be found upon infested trees in June, July, and August.

There are two generations of the caterpillar in a year in northern Illinois, possibly three farther south. The egg masses (Fig. 9) from which the caterpillars hatch may be found in fall, winter, and early spring. They form, when first deposited, frothy, oval, snowy



Fig. 7. Linden tree in a park in Chicago, defoliated by larvæ of White-marked Tussock-moth (*Homocampa leucostigma*). The few leaves on the tree have all appeared since the defoliation.

white patches about an inch in length, on the tree trunks, in the crotches of the larger branches, or in other more or less sheltered places, such as the edges of weather-boards and the under sides of the eaves of porches. Conspicuous objects at first, their color, under exposure to the sooty air of Illinois towns, is soon deadened to a dirty gray. The caterpillar begins to hatch from the over-wintering egg masses about the middle of June in Chicago (June 18 in 1909) and gets its growth in about a month. Feeding at first on the under side of the leaf, which it skeletonizes by eating off the soft tissue, it later eats inward from the edge of the leaf, devouring everything except the principal veins.

The young caterpillars drop down, hanging by silken threads, when the tree is jarred, and sometimes spin down without being disturbed, when they may be blown to a considerable distance by the

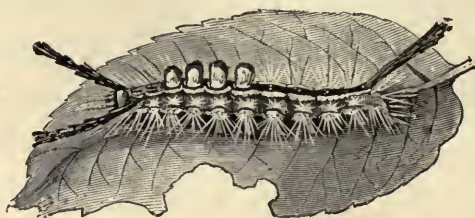


Fig. 8. White-marked Tussock-moth, *Hemerocampa leucostigma*, larva. Natural size.

wind. When nearly full grown, they are great travelers, going from tree to tree and even moving in large numbers from a defoliated tree to others near by. When full grown, the caterpillar



Fig. 9. White-marked Tussock-moth, *Hemerocampa leucostigma*, cocoons and egg masses on tree trunk in a park in Chicago.

spins, on the tree, a delicate grayish cocoon of silken web mixed with its own long hairs. It changes to a pupa within a few hours after the cocoon is finished and continues in this condition from ten days to two weeks.

The adults are moths, the females (Fig. 10) of which differ very widely from the males (Fig. 11) in the fact that they are almost absolutely wingless. The males have good wings and at



Fig. 10. White-marked Tussock-moth, *Hemerocampa leucostigma*, female and egg masses. Natural size. (Connecticut Experiment Station.)



Fig. 11. White-marked Tussock-moth, *Hemerocampa leucostigma*, male. Natural size.

least the average power of flight. They are of an ashy gray color, with dark wavy bands across the fore wings, a small black spot on the outer edge near the tip, a blackish stripe beyond this, and a minute white crescent near the hind angle. The wings, when expanded, measure about one and a fourth inches across. The female has little of the appearance of a moth, her wings being reduced to the merest rudiments. Her thick, oblong-oval body is of a light gray color, with rather long legs, and is distended with eggs. When she comes out she lays her egg mass on the cocoon from which she emerged—a fact which makes it plain that the species can spread only by way of the wandering caterpillars, or by the transportation of egg masses on young trees. The eggs of the last generation are ordinarily produced in September and the winter is passed in this condition.

Many insect parasites infest the pupa and do much towards holding the species in check. They are not usually abundant enough, however, to control it completely. In the fall of 1907, for example, one of my assistants reported that 75 percent of the cocoons of the tussock-moth in the Chicago parks were parasitized, but the caterpillars were nevertheless very numerous and destructive the

following year. Birds eat them, but not freely enough in the larger cities to reduce their numbers materially.

Three measures of destruction are applicable to this pest and sufficient for its control. These are the destruction of the egg masses in winter, banding trunks of uninfested trees in spring, and spraying infested trees in summer. The trunks and larger branches of trees, as well as all objects surrounding those infested the season before, should be carefully examined in winter and spring for egg masses, and all these within reach should be scraped or cut away and burned or otherwise destroyed. Those beyond convenient reach may be killed in place by touching each egg mass with a sponge or brush attached to the end of a long pole and dipped in crude creosote.

As the insect spreads from tree to tree only in the caterpillar stage, an uninfested tree may usually be protected completely by banding the trunk in such a way that the caterpillars from adjacent trees can not climb beyond the band. Sometimes, however, the branches of trees intermingle or touch in such a way that the caterpillars may go from one tree to the other without coming down to the ground. These bands should be applied to the tree soon after the caterpillars begin to appear in spring, and they should be renewed from time to time as they are made useless by exposure to the weather.

Either one of two kinds of bands may be used. The trunk may be surrounded, at a convenient height, by a belt nine inches wide of what is known as tree tanglefoot, applied with a brush; or bands of cotton batting about four inches wide may be tied closely about the tree by a string passed around the middle of the band, the upper half of which should then be turned down over it.

Where the preceding measures have been neglected and trees are being defoliated, the injury may be stopped by spraying with Paris green or arsenate of lead. This, however, is a difficult and somewhat expensive operation with large trees, and may be rendered unnecessary by destroying the egg masses and banding the trees as above described.

THE BROWN-TAIL AND GYPSY MOTHS

(*Euproctis chrysorrhæa* Linn. and *Porthetria dispar* Linn.)

These two frightful insect pests, altho present in America, the first for about forty years and the second for nearly half as long, have neither of them become established in Illinois, or indeed made any permanent appearance outside of New England. It will probably be long before the gypsy moth becomes an inhabitant of this state, its powers of migration being limited to the larva. The female, altho well provided with wings, has a very heavy body, and does not fly. The brown-tail moth, on the other hand, is a

strong, swift flier, and is virtually certain to occupy the whole country in due time, and it is further particularly likely to be introduced into the state direct from its European habitat on nursery stock imported from France. It winters in the caterpillar stage partly grown, hundreds of young collecting in single colonies on the trees, where they hibernate in closely webbed nests (Fig. 12). Hundreds of these nests containing living young were sent, in 1909, in-



Fig. 12. Brown-tail Moth, *Euproctis chrysorrhœa*, winter nests. Natural size. (Connecticut Experiment Station.)

to Illinois from France, and only the most active and fortunate inspection work prevented their escape in this state that winter. Worse than this, however, infested cases of nursery stock originating in France were reshipped into Illinois from other states where the force of inspectors was not sufficient to deal with the shipments arriving, and danger from these sources will continue year after year unless other states strengthen their inspection systems. Furthermore, since stock received in Iowa was shipped to this state that winter bearing living brown-tail caterpillars, it is extremely likely that the part retained in Iowa was similarly infested and that the brown-tail has thus obtained a lodgment there and possibly in other states adjacent to Illinois. If this is the case it will presently spread to our state also, especially as the moth flies long distances before the prevailing winds. It is important, for these rea-

sons, that our people should be fully informed and carefully instructed in advance in order that the first of these insects to appear may be detected and destroyed without delay.

The brown-tail moth is a caterpillar (Fig. 13) in the destructive stage, and, of course, goes thru the four stages of egg, larva, pupa, and adult. It is easily distinguished in the last of these stages



Fig. 13. Brown-tail Moth, *Euproctis chrysorrhæa*, larva. Natural size. (Massachusetts Experiment Station.)



Fig. 14. Brown-tail Moth, *Euproctis chrysorrhæa*. Slightly enlarged. (Massachusetts Experiment Station.)

from any American insect by the character to which it owes its name of "brown-tail," namely, a thick brushlike tuft of orange-brown hairs at the tip of the abdomen, especially in the female (Fig. 14). Otherwise both sexes are pure white thruout, except that occasionally there may be a few black spots on the fore wing of the male. They measure about an inch and a quarter from tip to tip of the expanded wings. Any pure white moth of approximately this size with an orange-brown tuft of hairs at the tip of the abdomen may be at once set down as the brown-tail; and any one seeing it in Illinois will render a notable public service by reporting the fact promptly to the State Entomologist, at Urbana, Ill.

The winter nests of these caterpillars are also easily identified, since no native Illinois species hibernates on either tree or shrub in colonies of living caterpillars inclosed in a web. Any such cluster of young caterpillars so protected by a common web may consequently be set down at once as the brown-tail and should, of course, be promptly destroyed and the facts reported to the Entomologist. Nurserymen importing European seedling stock can

not guard too carefully against the accidental importation of this insect pest, as it is widespread in Europe, breeding abundantly on hedges, trees, and various shrubs, and making its way into the nursery from infested surroundings.

The brown-tail feeds upon practically all deciduous trees and many shrubs and even upon herbs. Thousands of fruit trees in the vicinity of Boston have been killed by it, and damage to maples and elms in wooded regions has caused the forest to appear brown in June, an injury which, if repeated for three or four years, has killed many trees. As the caterpillars pass the winter about a quarter grown, they begin to devour the leaves of trees as soon as these put out in spring, and even eat the buds and blossoms before the leaves have spread. Old trees may thus lose all their buds, or, if not, the foliage itself may be devoured at a later date.

The caterpillar reaches its full size in New England during the last half of June, and the moths emerging, fly about and lay their eggs some twenty days later. The small round eggs are laid in brownish masses (Fig. 15) on the under side of leaves, each mass

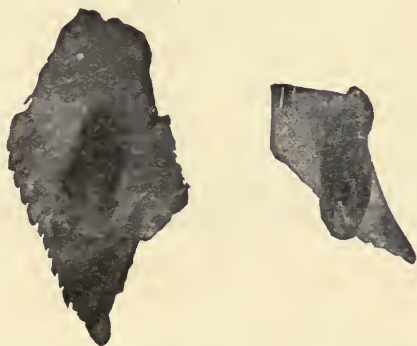


Fig. 15. Brown-tail moth, *Euproctis chrysorrhoea*, egg masses on leaves. Natural size. (Connecticut Experiment Station.)

two-thirds of an inch long by a fourth of an inch wide, and containing about three hundred eggs. The full-grown caterpillar is about two inches long, reddish-brown, with an interrupted white stripe on each side and two red dots on the back near the hind end. It is also blotched with orange and is covered with tubercles bearing long barbed hairs, those on the back and sides with short brown hairs additional, which give them, when magnified, a velvetlike look. The young hibernating larvæ are blackish, with reddish-black hairs and black heads. The pupa is formed among the leaves on the infested tree or shrub, most frequently at the tips of the branches, where several caterpillars may spin a loose web together, each forming, how-

ever, its own cocoon within the web. When the insect becomes abundant, cocoons may be found under fences and at the edge of clapboards on houses, and in many similar places.

One of the most disturbing peculiarities of a brown-tail infestation is the fact that the long barbed hairs already mentioned are covered with a poisonous excretion, and that they readily pierce the skin, causing an irritating rash which occasionally results in serious illness. "Indeed," says Dr. Howard, "it is not necessary for the caterpillar itself to come in contact with the skin; at certain times of the year it seems as though the hairs were actually floating about in the air. At the time of the caterpillar's change of skin, and particularly at the time of the spinning of the cocoon and the final change, certain of these hairs appear to become loosened in such a way that they are carried by the wind." Others report that these poisoned hairs may collect on clothing hanging on the line, to the intense annoyance of those who wear it.

The readiest and most obvious means of controlling the brown-tail moth, and certainly the easiest one, is the collection and destruction of the winter nests after the leaves have fallen. After April the only practical remedy is spraying the trees with an arsenical mixture. The young caterpillars are readily enough destroyed with arsenate of lead, but the older ones become resistant to poison sprays, and as much as five pounds of the arsenate to a barrel of water has been found necessary to kill the full-grown caterpillar.

When this insect appears within our borders it will be most destructive in parks and towns and forest plantations, since these are not regularly sprayed and will require a special treatment to protect them. It will also aid the San Jose scale in putting out of business the neglectful or indifferent orchardist, but the business fruit grower, who values his property and takes care of it as well as he can, will have much less to fear from this insect, since his ordinary spraying operations will be practically certain to destroy it as it enters his orchard. The fact, however, that the full-grown caterpillar requires a heavier insecticide treatment than does the codling-moth and the canker-worm, for which most of our spraying is done, may make it necessary to go over the orchard in winter to remove and destroy the hibernating colonies.

The gypsy moth may be more briefly considered, altho it is even a more destructive pest than the brown-tail, especially for the reason that it eats the leaves of evergreens—trees which are often killed by a single defoliation. It is conveyed to distances in the caterpillar stage only by accident. Passing wagons, automobiles, trolley cars, or even railroad trains, may carry the caterpillars to uninfested districts, but in this way its spread is slow, especially as all possible measures are being taken in infested districts of New England to keep the roadsides free from the pest,

and thus to reduce to a minimum the possibility of an extensive spread.

The caterpillar of the gypsy moth (Fig. 16) is a voracious feeder, eating the leaves of nearly every kind of tree or shrub, and devouring sometimes also grasses and field and garden crops. The very fact that it spreads but slowly makes it locally all the more



Fig. 16. Gypsy Moth, *Porthetria dispar*, larvæ. Natural size.
(Connecticut Experiment Station.)

injurious, since it accumulates in enormous numbers upon infested localities. Forests, orchards, gardens, parks, and street shrubs and trees may be stripped of every leaf between the first of May and the middle of July.

The insect winters in the egg stage, the eggs being plastered in conspicuous masses (Fig. 17) on the trunks of trees and on various other objects. They may readily be destroyed by touching them with a mixture of creosote oil, 50 percent, carbolic acid, 20 percent, turpentine, 20 percent, and coal-tar, 10 percent, in sufficient quantity to soak the mass. The caterpillar may also be killed on the trees with arsenical poisons, but these must be applied in unusual quantities, since the gypsy moth is not readily poisoned in the caterpillar stage. Five pounds of arsenate of lead to fifty gallons of water will kill the young, but even this can not be depended upon for the full-grown caterpillars. These are about three inches long, of a sooty or dark gray color. Along the back is a double row

of blue spots, followed by a double row of red spots, and the back is marked with yellow. The cocoon is formed among the leaves like that of the brown-tail and the moths appear from the middle of July to the middle of August. The male is bluish-yellow, expanding about an inch and a half, and the female (Fig. 17) is



Fig. 17. Gypsy Moth, *Porthetria dispar*; female moths, laying eggs on bark. Natural size. (Connecticut Experiment Station.)

nearly white, somewhat spotted and barred with black. Its wing expanse is about two and a fourth inches. The female is very sluggish and so heavy that she can not fly; but the male is an active flier.

The oval egg masses, about one and a half inches long by three-fourths that in width, are laid in summer on the trunks of trees, on fences, on the sides of houses, and in various other places. Large holes in old trees are often found filled with them. The caterpillars feed principally at night, especially after they reach some size, and they seek to hide during the day, often coming down upon the larger limbs and trunk of the infested tree in search of hiding places. This habit has led to the use of bands of burlap tied around the trunks of trees, under which the caterpillars may rest during the day and where they can be easily destroyed by hand.

The probabilities of widespread destruction to forest, park, and orchard properties by these insects are greatly reduced by the truly

tremendous and unexampled work being done by the United States Department of Agriculture and the state of Massachusetts in bringing from Europe the native parasites of these insects. This work is making successful progress, and it is all the more hopeful because the parasites of both these species seem to keep them substantially in check in the Old World, where they rarely become seriously destructive.

THE FOREST TENT CATERPILLAR

(*Malacosoma disstria* Hbn.)

There occasionally appears in the forest region of southern Illinois an overwhelming eruption of caterpillars which denude large areas of woodlands, especially the oaks and the maples, and the black and sweet gum trees, and thence invade orchards, parks, and town premises, carrying the same destruction to fruit and shade trees generally. This is one of the species which moves in masses such as actually to delay the passage of railroad trains, piling up



Fig. 18. Baltimore Oriole attacking nest of Forest Tent Caterpillar, *Malacosoma disstria*. (New Hampshire Experiment Station.)

on the rails several inches deep. It is known to entomologists as the forest tent caterpillar, but in the South it is commonly called "the caterpillar" simply. The name of "tent caterpillar" is, in fact, inappropriate for it, since it spins but little and never makes a tent. It is closely allied, however, to the common tent-caterpillar of eastern orchards and has received its common name because of this resemblance.

When full grown (Fig. 19) it is about two inches long and a quarter of an inch thick. It is of a brownish general color, and is conspicuously marked with a series of whitish or cream-colored spots down the middle of the back. On the upper part of each side

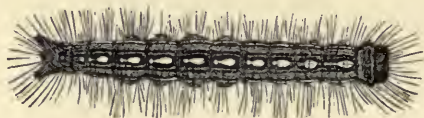


Fig. 19. Forest Tent Caterpillar, *Malacosoma disstria*, larva. Natural size.

is a rather broad blue line edged above and below with a yellowish-brown line. When disturbed it drops from the branch and hangs suspended in mid-air by means of a fine thread spun from the mouth. In moving about on the tree these caterpillars follow each other in single file. They feed mostly in the tops of the trees, often eating out the central part of the base of a leaf, allowing the remainder to fall to the ground. When preparing to molt, they mass together on the limbs and may continue thus for a day or two. They often form similar masses in stormy weather and in general when at rest. The eggs (Fig. 20) are laid in a thick hard band around a twig and covered with an impervious varnish. From these the young hatch in early spring, sometimes before the appearance of the leaves on which they depend for food.

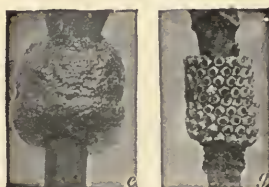


Fig. 20. Forest Tent Caterpillar, *Malacosoma disstria*: e, egg ring recently laid; g, hatched egg ring. Slightly enlarged. (Cornell Experiment Station.)

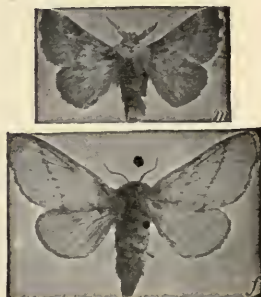


Fig. 21. Forest Tent Caterpillar, *Malacosoma disstria*: m, male; f, female. Natural size. (Cornell Experiment Station.)

They are capable, however, of fasting for a considerable time without injury, and they may even survive the destruction of the leaves by late frosts. They scatter for pupation late in May or early in June, spinning cocoons which they fasten among clusters of leaves or exposed on fences and in other similar situations. There is but a single generation in a year. The parent moths (Fig. 21) measure about an inch and a quarter across the expanded wings. The general color is brownish-yellow and the fore wings are marked by two straight dark brown lines which cross them obliquely, parallel with each other and the hinder edge.

Trees may be protected by spraying with arsenical poisons shortly after the young caterpillars begin to appear, or by clipping off in winter the twigs bearing the conspicuous belts of eggs and destroying these by burning. Even overwhelming hordes may be arrested by surrounding the tree trunk with a band of cotton batting about four inches wide, tied around the middle with a string, the upper part being then turned downward over the string. Or, the trunk may be surrounded with a band of printers' ink applied as described in the article concerning the common canker-worm (p. 488).

THE COMMON CANKER-WORM, OR SPRING CANKER-WORM

(*Paleacrita vernata* Peck)

The common canker-worm is best known as a pest of the apple orchard, but it is sometimes even more destructive to elms (Fig. 22) than to apple-trees. It feeds also on cherry, at first eating small holes thru the leaves, but when larger devouring the whole leaf except the midrib and some of the coarser veins. Modern methods of orchard management require a regular and frequent spraying with arsenical poisons as a protection of fruit against the codling-moth, and this has the incidental effect—often unnoticed by the orchardist—of speedily killing off any colony of canker-worms which may have chanced to make a start in the orchard. Hence it is only neglected orchards, or those not in bearing either because too young or by reason of a crop failure for the year, which are liable to serious canker-worm injury.

With the elm, however, the case is different. The canker-worm lives on this tree as willingly and successfully as on the apple. Elms are rarely sprayed in Illinois, and if the canker-worm once comes to infest them there is no natural end to the injury except the death of the tree, unless, indeed, the parasites of the insect and other natural checks on its increase may happily suppress it before that event.

The spraying of large elms is, of course, a difficult and expensive operation, and canker-worms are less susceptible to arsenical poisons than many other insects. There is, however, a much cheaper and more convenient method of protecting the elm, by which advantage is taken of two features in the economy of the insect. When the caterpillars are full grown they leave the tree to pupate in the earth, and the female moth emerging, being wholly without wings, can only reach the tree to lay her eggs by climbing up the



Fig. 22. Injury to elms at Calamus Lake, Niantic, Illinois, by common Canker-worm (*Paleacrita vernata*).

trunk. If this is encircled at the proper time by a sticky band impassable by her or by young canker-worms just hatched from the egg, the tree is virtually secure against canker-worm injury except as worms may reach it from neglected trees with which its own branches interlace.

Altho the female canker-worm (Fig. 23, *b*) is wingless, the male (Fig. 23, *a*) has two pairs of rather large, thin, ashy or brownish-gray wings, the first pair with a broken whitish band near the outer edge and three interrupted brownish lines between that and the body. There is also a short oblique black mark near the tip of the wing, and a black line at its edge at the base of a fringe of hairs. The eggs (Fig. 24, *b*) are about .03 of an inch long, oval in outline, and of a pearly luster at first, changing to yellowish-green with a golden, greenish, or purplish iridescence. They are

laid in irregular masses, often as many as a hundred together, and usually hidden in crevices of the bark of trees.

The female comes out of the ground to lay her eggs from February to April, the date varying with the latitude and the season. The young caterpillars appear about the time that the apple-tree unfolds its leaves, commonly, in this state, in April or early May, and they usually get their growth in about a month from the time when they issue from the eggs. They then go into the ground to a depth of two to five inches, each one in a small cell, where they change to the chrysalis, remaining there until the following



Fig. 23. Common Canker-worm, *Paleacrita vernata*: a, adult male; b, female; c, portion of female antenna; d, joint of abdomen, enlarged; e, ovipositor.



Fig. 24. Common Canker-worm, *Paleacrita vernata*: a, larva; b, cluster of eggs, natural size, with one enlarged; c, side view of one of the segments, d, back view of same, both enlarged.

winter or early spring, when the change to the adult insect takes place. There is thus but a single generation produced each year. The canker-worm is widely distributed thruout the country and may occur in destructive numbers in any part of Illinois. Its feeble power of locomotion prevents its rapid spread in any locality, but by concentration of its injuries it is the more destructive where it does occur.

In its injurious or caterpillar stage (Fig. 24, a) it is readily recognized. It has a long and slender form and the habit of a "looper" or measuring worm. When not eating it usually adheres only by its hinder prolegs, extending the body from this point of support at an angle of about 45 degrees. As it is colored much like the bark of a tree, it then has the appearance of a stubbed twig. It also has the habit of spinning down from the tree at the end of a thread, particularly if the branch is jarred or shaken. Both the just-mentioned habits are doubtless advantageous to it; the first by concealing it to some degree from the observation of birds and the second by putting it beyond their reach. The full-grown canker-worm is about nine-tenths of an inch in length and may vary from greenish-yellow or gray to dusky or even dark brown, with paler stripes along the sides. A close examination will show also two light lines running close together along the middle of the back.

The young are usually olive-green. The wingless female, with its small gray body from a quarter to two-fifths of an inch in length and its rather long legs, gives more the impression of a spider than that of a moth. The chrysalis is pale grayish-brown, with a dark green tinge on the wing sheaths, and measures about a third of an inch in length.

This insect has not recently been abundant in Chicago, but its capacities for injury are well illustrated in a recent attack on elms at Big Rock, Kane county. Some ten years ago it was generally prevalent thruout the south-central part of the state, both in towns and in forests, to which it had apparently escaped from neglected orchards, although in some cases orchards were invaded in turn from adjacent forests. A most threatening attack was made on the magnificent old elms of Jacksonville, but a vigorous campaign, first of spraying and later of the application of adhesive bands, presently brought the outbreak under control.*

A cheap and available band for the trunk of a tree is made by laying around the trunk first a strip of unglazed cotton batting two or three inches wide and over this a four- to six-inch strip of tarred paper tied around the middle with ordinary wrapping twine. Upon this paper belt should be spread a layer a quarter of an inch thick of cheap printers' ink with which a small amount of car wheel oil has been mixed, just enough to make it easy to spread. If the tarred belt becomes slightly hardened by exposure so as to permit an insect to cross, it may be made sticky again by brushing it with a little of the same kind of oil. The cotton batting beneath the paper is necessary to keep the young canker-worms or the female moths from crawling up behind the paper where the roughness of the bark would give them passageway. These bands should be placed on the tree as early as the middle of February or the first of March, the time varying according to the latitude, and they may be safely removed by the middle of June. The cost of the bands will approximate ten cents a tree.

If the canker-worms have already ascended the tree, it is sometimes necessary to spray the leaves with an arsenical poison, which may be either arsenate of lead or Paris green, the latter at the rate of one pound of the poison and one pound of lime to seventy-five gallons of water. If the arsenate of lead is used, three pounds of it dissolved in fifty gallons of water will kill even the full-grown caterpillars.

*The Canker-worm on Shade and Forest Trees. By S. A. Forbes. Twenty-second Report State Ent. Ill., page 139.

THE LILAC BORER

(Podosesia syringæ Harris)

Among the borers whose instincts lead the female to choose, for the deposit of her eggs, scars or injured places on the bark of trees and shrubs, with the effect greatly to increase the injury and

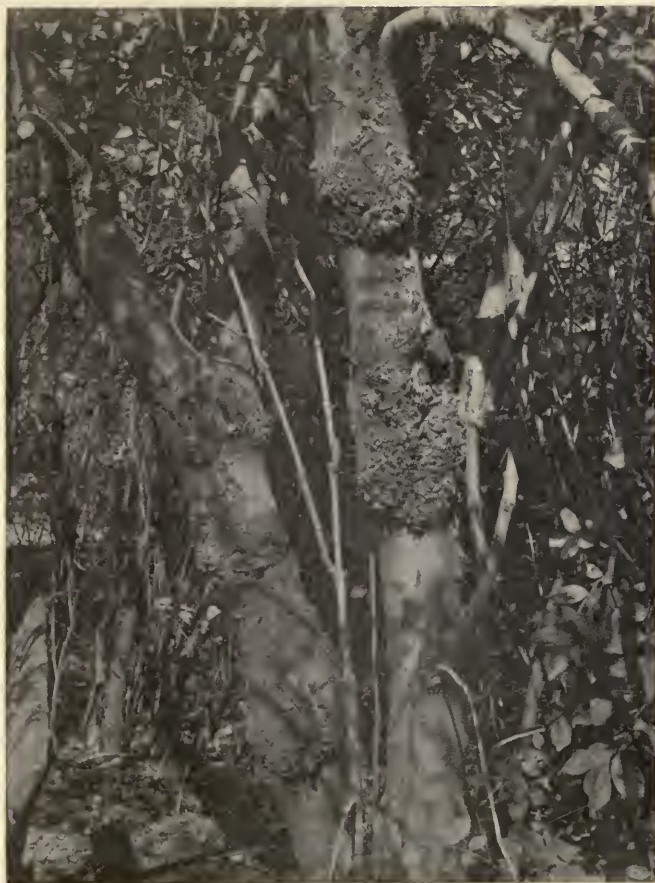


Fig. 25. Trunk of ash in one of the parks in Chicago, showing injury by the Lilac Borer, *Podosesia syringæ*.

to prevent its healing, is a species commonly known as the lilac borer (*Podosesia syringæ*), because it was first noticed to infest lilacs. It is much more important, however, by reason of its injuries to various species of true ashes,* and to the mountain ash,

*It has been found injurious to the lilac (*Syringa* sp.), to the mountain ash (*Sorbus americana*), and to the white, green, and English ashes (*Fraxinus americana*, *lanceolata*, and *excelsior*).



Fig. 26. Trunk of ash, in one of the parks in Chicago, showing injury by the Lilac Borer, *Podosesia syringæ*.

on the trunks and branches of which it produces large, rough, scar-like outgrowths from knots, roughened places, or wounds, by undermining the bark and boring into the wood. (See figures 25 and 26.)

The eggs are laid in summer in masses on rough, scarred, or knotty places. They hatch in about six days and the young borers eat thru the bark into the outer layers of the sapwood, where they mine irregularly about, penetrating the harder wood and going to the center of small branches. (Fig. 27.) In fall, when they are nearly or quite full grown, they make a hibernating cell by plugging up the burrow both before and behind with frass, and there they pass the winter as larvæ. They do practically no bur-

rowing in spring, but pupate in April or the first part of May. As a preparation for pupation, they burrow outward and cut their way thru the bark, leaving only a thin outer film to close the pupal cavity. By means of short teeth with which each segment of the abdomen is armed, the pupa, when mature, works its way out of



Fig. 27. Lilac Borer, *Podoseia syringæ*. Burrows in ash made by larvæ. Slightly reduced.



Fig. 28. Lilac Borer, *Podoseia syringæ*, larva. About 5 times natural size.

its gallery until it projects some three-quarters of an inch. The winged insects, altho moths, closely resemble wasps in movement, color, and form. They make their appearance from the latter part of April to the middle of June in central and northern Illinois.

The borer or larva (Fig. 28) is very variable in length. It is white, yellowish anteriorly, the head of a bright mahogany color, becoming very dark at the mandibles, which are stout, broad, and provided with five teeth. The segments of the body are distinctly

marked, somewhat flattened, the first segment reddish and leathery above, the last with a broad yellowish patch.

The moth (Fig. 29) has a black head, a deep brown thorax more or less marked with bright chestnut-red, and a black abdomen sometimes marked with chestnut, but sometimes with a small yellow spot on each side of the fourth segment, or with the segments banded with yellow. The femora are black, the anterior pair of the tibiæ orange, the middle and hind tibiæ black with orange bands.



Fig. 29. Lilac Borer, *Podosesia syringæ*, adult.
Slightly enlarged.

The tarsi are yellow, the hind pair with a black band above. The fore wings are deep brown, with a violaceous luster and usually with a rusty red dash on the outer part. At the base is a transparent streak. The hind wings are transparent and yellowish, the veins, discal marks, and margins deep brown, sometimes tinged with red.

The spread of the wings is from an inch to nearly an inch and a half, the females being considerably larger than the males.

This insect is very abundant and destructive, especially to the green ash in Chicago parks, and has been bred by us also from the white ash at Kankakee. Its injury is very noticeable and characteristic, especially on the trunks of small trees. Sometimes the smaller branches break off at the point of injury, but this does not usually happen until after the moth has escaped. George D. Hulst says, writing of these insects in New York: "In this section they are very destructive to both lilac and English ash. Large shrubs of lilac are now very rarely seen, and the English ash is being rapidly exterminated. In the latter I have seen the wood completely ridled with the holes made by the larvæ and the entire tree dead."

To check the multiplication of the species and the spread of the injury it will be sufficient to cut away and burn infested branches

and trees in winter. It may also be practicable to protect trees especially exposed by painting rough, knotty, and injured places on the bark with a poison mixture commonly used by orchardists to prevent infestation by ordinary borers. A number of substances are available for this purpose, the simplest of which, perhaps, is a mixture of soft soap and soda, with the addition of Paris green. The following is a convenient formula: To a saturated solution of washing soda add soft soap sufficient to make a thick paint, and to each ten gallons of this wash add a pint of crude carbolic acid and half a pound of Paris green. This may be painted thickly upon scarred, roughened, or knotty surfaces in April and early May and renewed as necessary until August.

TWO POPLAR BORERS

(*Memythrus tricinctus* Harris)

(*M. dollii* Neum.)

Two boring caterpillars, similar in appearance, but differing in the larval or boring stage mainly in size, infest poplars in this state to an injurious degree. They are most destructive to young nursery trees, particularly to the balm of Gilead (*Populus candicans*), but the Carolina poplar (*P. deltoides*), Figure 30, is also sometimes badly infested. They are generally present thruout Chicago, often infesting trees which are likewise injured by a boring larva, *Cryptorhynchus lapathi*, discussed on p. 502. They have also been found by us in park and street trees in several Illinois cities and towns from Centralia northward. In the case observed by us in Chicago, the eggs of one of these species, which one we do not know, were deposited July 22, mostly in a crevice of the bark or in the neighborhood of a bud, and young larvæ were first seen July 26, altho some of these had apparently hatched at least a week before. The borers winter in the larval stage in the wood, pupate in spring, and come out as winged moths in June and July—at various dates from June 18 to July 26, if we may judge by results obtained in our insectary. From a willow in Cook county a specimen of *M. tricinctus* was bred which emerged July 2.

The boring larvæ are whitish caterpillars, with brown or yellowish heads and a smooth neck shield. The two species are most easily distinguished by the markings of the head and by the number of hooks on the abdominal legs. In *M. tricinctus* the head is yellowish and mottled with large patches of brown, while the abdominal feet have from eighteen to twenty-two hooks in a row. In *M. dollii*

(Fig. 32) the head is brown with large darker patches on the sides, and a black band or blotch between the antennæ. The abdominal feet have ten to fifteen hooks in each row. Both these species are



Fig. 30. Small poplar infested with sesiid borers (*Memphrus*).

distinguished from some other borers of their family by the fact that the first segment of the thorax bears two oblique dark marks, approaching each other behind.

The winged insects are readily distinguished by a comparison of the wings and abdomens. In *tricinctus* (Fig. 35) the fore wings are violaceous-black, the hind wings are transparent, and the abdomen is black with three or four yellow bands. In *dollii* (Fig. 36) the fore wings are brown, the hind wings are brown and



Fig. 31. Poplar Borer, *Memythrur tricinctus* or *dollii*, egg. Greatly enlarged.



Fig. 32. Poplar Borer, *Memythrur dollii*, larva. About 3 times natural size.

opaque, except at the base, and the abdomen is brown, sometimes with one or more yellow bands.

In our work with these borers it was not at first known that two species were concerned, and the larvæ were not distinguished in our notes. It was only when the adults appeared that the specific distinctions were established.



Fig. 33. Poplar Borer, *Memythrur tricinctus* or *M. dollii*, pupa. About 3 times natural size.



Fig. 34. Poplar Borer, *Memythrur tricinctus* or *M. dollii*, anal end of pupa. Greatly enlarged.



Fig. 35. Poplar Borer, *Memythrur tricinctus*, adult female. About twice natural size.

A third species, allied to the two above mentioned, but more commonly found infesting ninebark (*Opulaster opulifolius*), has been once bred by us from poplar at Chicago.



Fig. 36. Poplar Borer, *Memythrur dollii*, adult. About twice natural size.

A VIBURNUM BORER (*Sesia pictipes* G. & R.)

A boring caterpillar, somewhat larger than that described from ninebark and dogwood, but otherwise extremely similar, has been found doing considerable damage to viburnum shrubs in all the parks of Chicago, and, in one case, to wild black cherry at Riverside. It burrows beneath the bark, frequently killing the branches. It spends the winter in the larval stage, and has emerged in our breeding cages during the latter part of June, from the twentieth to the twenty-fourth. Elsewhere it is reported to emerge during June and July. The species is known also from plum, cherry, beach-plum, peach, Juneberry, and chestnut, and has been bred from the black-knot of the plum.

The placing of the eggs has not been noticed by us, but another observer, Dr. Bailey, found a cluster of them, ninety-two in number,

on the under surface of loosened bark a few inches from the root of a badly infested plum-tree.

The removal and destruction of infested branches at the proper time of the year, that is, during the winter and spring, is the only measure practicable for the control of this pest.

The winged insect has a blue-black head, thorax, and abdomen, the thorax with a narrow pale line each side, and the abdomen with a narrow pale yellow ring on the second and fourth segments, encircling the body completely on the latter. The fore wings are transparent, with very narrow blue-black margins, and a narrow, straight, discal mark. The inner margin is sometimes scaled with pale yellow. The hind wings are transparent, with a very narrow outer margin and no discal mark. The spread of the wings is from 15—26 mm., the smaller specimens being males.

THE MAPLE BORER

(*Sesia acerni* Clem.)

The worst of the borers of the maples, both hard and soft, very common and destructive to soft maples in Chicago, and common also in towns thruout the state, is a white or nearly white caterpillar (Fig. 37, *a*) about half an inch long when full grown, with a yellow head and a neck shield of a paler tint. It is especially injurious to young trees, but usually originates in some surface injury which attracts the parent moth in search of a place of deposit for her eggs.

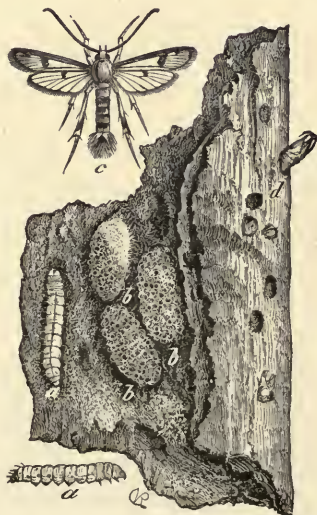


Fig. 37. Maple Borer, *Sesia acerni*: *a, a*, larvæ; *b, b, b*, cocoons; *c*, adult; *d*, pupal skin left in mouth of burrow.

It burrows mainly just beneath the bark, where it can be found and destroyed in fall or early spring. It comes to maturity in May or June, eats its way nearly thru the bark, and pupates there. We collected the adult in considerable numbers, at electric lights, in Urbana, from May 18 to June 3, 1887. When ready for its transformation the pupa wriggles partly out of its burrow, and the adult insect escaping leaves the empty pupa-case still sticking in the opening, which is about an eighth of an inch across. (Fig. 37, *d.*)

The adult is a handsome wasplike moth (Fig. 37, *c*; Fig. 38) with thin transparent wings, a slender yellow body banded and trimmed with red, and a brushlike tuft of hairs at the tip of the



Fig. 38. Maple Borer, *Sesia acerni*, adult. About 3 times natural size.

abdomen. The eggs are laid chiefly in rough or injured places, almost wholly in the trunk of the tree, and not in its branches. The effect of the injury is to kill the bark undermined, and to enlarge surface wounds and prevent their healing, converting them into permanent, rough, and very unsightly scars. Sometimes the tree is killed by a girdling of the trunk.

To prevent attack by these borers the tree should be protected from injury, and such wounds as it receives should be painted over or covered with grafting wax. Dr. Felt, State Entomologist of New York, says that "the deposition of eggs could probably be prevented to considerable extent by treating the trunks of trees about the middle of May with a wash prepared as follows: Thin one gallon of soft soap with an equal amount of hot water and stir in one pint of crude carbolic acid (one-half pint, refined), let it set over night and then add eight gallons of soft water. Apply thoroughly to the trunk, especially about all crevices and wounds, from the ground to about six or eight feet high, and renew if necessary before the middle of June." As the borers work near the surface, they can be easily dug out and destroyed in fall.

THE NINEBARK BORER

(Sesia scitula Harris)

Dogwood and ninebark shrubs (*Cornus* sp. and *Opulaster opulifolius*) in the Chicago parks are generally infested, and often seriously injured, by a boring or girdling caterpillar (Fig. 39) which works just beneath the bark, mainly at the junction of the branches



Fig. 39. Ninebark Borer, *Sesia scitula* larva.
About 3 times natural size.

or in the neighborhood of an old dormant bud. The burrows of the borer sometimes extend lengthwise of the branch, and sometimes girdle it near its origin. In 1908 nearly every shrub of the ninebark in Washington Park was infested, and many of the branches were killed by this larva. The species also infests the chestnut, and has been bred from galls on twigs of the oak.

The creamy white larva, half an inch long in September, passes the winter in its burrows, and emerges, according to our observations, in late June or in July. The head is brown, darkening almost to black towards the mandibles. The prothorax is slightly brownish, with two oblique brown markings on its posterior half. The re



Fig. 40. Ninebark Borer, *Sesia scitula*, adult female.
About 3 times natural size.

maining segments are creamy white, except the last, which is pale reddish-brown.

The winged insect (Fig. 40) is deep blue-black on the thorax and abdomen, the former with a yellow line and a yellow patch on each side, and the latter with a yellow line at its base and, in the

male, a narrow yellow ring on the second and fourth segments, broadening below on the fourth to cover the whole surface. In the female the fourth segment is yellow both above and below. The head and antennæ are black, the femora blue-black, and the tibiæ yellow. The fore wings are transparent, except the borders and the discal mark, which are blue-black. The outer margin is marked with yellow rays. The hind wings are transparent, with very narrow blue-black margins. The spread of the wings is from 18—22 mm.

This insect can evidently best be destroyed by cutting out and burning infested branches in winter or early spring.

THE BAG-WORM

(*Thyridopteryx ephemeraformis* Harris)

One sometimes sees hanging from the branches of trees, in late summer or in fall or winter, especially in the southern part of the state, rough excrescences, about two inches long, shaped somewhat like a spindle full of yarn, soft to the touch, and more or less covered with pieces of dead leaves which seem to be woven into their web-like substance (Fig. 41, *f*). In summer it may be further noticed

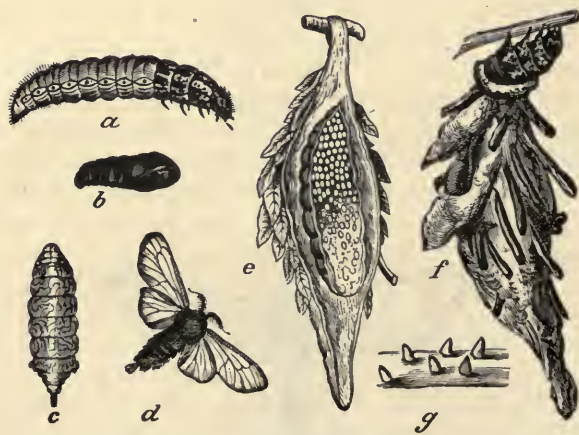


Fig. 41. Bagworm, *Thyridopteryx ephemeraformis*: *a*, larva; *b* and *c*, pupa, side and back views; *d*, adult; *e*, case containing the eggs; *f*, larva in case; *g*, eggs. Natural size.

that these spindle-shaped sacks can creep along the twig, and that there projects from the end nearest the twig the head and front part of a caterpillar, the remainder of which is enclosed in the protecting bag. In winter this is hung to the tree by a rather tough ligament composed of material like spider-web. An examination of these peculiar bodies at that season will show either that they are

virtually empty, or that they contain a mass of soft yellow eggs. (Fig. 41, *e*.)

The insect known as the bag-worm, to which these constructions are due, is in several respects one of the most curious in Illinois. Altho the parent form is a moth, the female is wingless and naked (Fig. 41, *c*), looking more like a grub than a moth, and the wings of the male, instead of being covered with scales, are smooth and transparent, somewhat like those of a wasp. (Fig. 41, *d*.) The caterpillar infests a considerable variety of both fruit and shade trees, including among the latter evergreens (especially red cedar and arbor-vitæ, Fig. 42) and several kinds of deciduous trees.



Fig. 42. Bag-worm, *Thyridopteryx ephemeraformis*, cases hanging on arbor-vitæ twig.
(Ohio Experiment Station.)

It does its injury by eating the leaves of trees, and its numbers are often such that they may take virtually every leaf off a tree of considerable size.

The eggs, contained during the winter in the bag-like cases on the trees, hatch the following May or June, and the young caterpillars begin at once to spin for themselves small conical cases (Fig. 41, *g*) to which they fasten pieces of leaves from the tree upon which they are feeding. As they grow these cases are enlarged until they take the form and dimensions already described. The caterpillars (Fig. 41, *a*) travel but slowly, and seldom leave the tree upon which they were hatched until they are about full grown,

when they are likely to spin down and wander about. They change to the chrysalis (Fig. 41, *b*) within the bags, which they fasten to the twigs of the trees as a preliminary, but the grublike female moth, destitute of wings and with only minute and useless legs, deposits her eggs within her native sack, works her way out of it, drops to the ground exhausted, and dies. The winged males (Fig. 41, *d*) appear in September and October, and soon thereafter the eggs are laid.

The bag-worm is a southern insect in its general range, and is rarely seen in northern Illinois. It increases in importance southward, and in southern Illinois is often a troublesome pest. In a general trip to eighteen towns, well distributed thruout the state, Mr. J. J. Davis, in 1910, found the bag-worm in four out of six southern Illinois towns visited, but in no others.

The simplest method of destroying these insects is to collect the bags during the winter and burn them—a thing easily done with the aid of pruning shears if they can not be reached by hand. If this measure is neglected, infested trees may be cleared by spraying them with arsenical poisons soon after the hatching of the eggs—the latter part of June or early July. A pound of arsenate of lead to forty gallons of water is a safe and effective poison.

THE POPLAR AND WILLOW BORER

(*Cryptorhynchus lapathi* Linn.)

The weeping willow, the Carolina poplar, the balm of Gilead, and the red birch are ornamental trees of sufficient popularity to make the existence of any insect pest destructive to them a matter of general interest. The Carolina poplar especially has had an enormous distribution of late years in Illinois towns, largely because of the ease and certainty with which it may be raised, and the rapidity with which it grows in our soils.

The advent into this country nearly thirty years ago of a European snout-beetle well known in the Old World as a destroyer of alders, poplars, and willows, and occasionally injurious to birches also, has seriously endangered our American plantations of these trees. Detected first in New York in 1882, and found on Staten Island in 1886, it appeared in considerable numbers near Buffalo by 1896, and the following year was reported as abundant in Boston, Mass., and very destructive there to willows and poplars of all kinds, and to the red birch. By 1901 it had reached northeastern Ohio; in 1903 it was found in two Wisconsin nurseries; and in 1904 it was reported from North Dakota in poplars lately brought into that state from New York. In Illinois it was first seen by us in 1908 in Carolina poplars at Chicago; but once detected there it was soon found to be generally distributed and very destructive to both poplars and willows in all parts of the city. (Fig. 43.) It has not yet occurred,

to our observation, elsewhere in Illinois. Wherever it appears it multiplies locally, but makes a slow spread, a fact apparently due to the sluggishness of the parent beetle, which, although provided with wings, makes extremely little, if any, use of them. In consequence



Fig. 43. Small poplar tree in Chicago showing dying of upper branches resulting from attacks of the Poplar and Willow Borer, *Cryptorhynchus lapathi*.

of this fact, an infested grove may be nearly destroyed before another, near at hand, becomes even infested. It extends its range most readily along watercourses by means of the willows and cottonwoods with which our streams are likely to be fringed. Its spread to distant points seem to have been mainly, if not altogether, by way of the nursery trade, especially that in poplars and willows of various kinds. These facts make it particularly important that

the signs of its presence should be generally known, in order that it may be promptly recognized and suppressed upon its appearance in any new locality.

Injury by this borer may be suspected when the general health of a tree is evidently affected, where there are dead patches of the bark, irregularly cracked open (Fig. 44, 45), or where openings in



Fig. 44. Injury by Poplar and Willow Borer,
Cryptorhynchus lapathi.

the bark give exit to a soft excrement like moist sawdust mixed with fine splinters. The burrows beneath the bark, made chiefly in the cambium layer, are irregular in direction, sometimes girdling a small tree, and show nothing of the symmetrical pattern made by many borers which undermine the bark. Those of the older larvæ dip into the wood, usually reaching the center of the branch unless this is large. These deeper burrows finally become filled with powdered wood and splinters, except a chamber at the farther end in which the larva pupates. In the active boring stage these insects are soft, yellowish, fleshy, cylindrical, footless grubs (Fig. 46) with a pale-brown head and darker mouth-parts. They are half an inch long when they reach full size, which is about the last of June for those most advanced. At this time, however, young larvæ may be found under the bark down to a fifth of an inch in length.

The adult beetles (Fig. 47) begin to appear in July, and continue abroad at least until October. They are well marked and easily distinguished insects, a little more than a quarter of an inch

long, thick-bodied, with a roughened and punctured surface, and a stout curved beak projecting downward from the head. The general color is dark sooty brown, more or less specked and spotted



Fig. 45. Injury by Poplar and Willow Borer, *Cryptorhynchus lapathi*.



Fig. 46. Poplar and Willow Borer, *Cryptorhynchus lapathi*, larva. About 4 times natural size.

with gray, and there is a very conspicuous large patch of light gray on the hinder end of the wing-covers, contrasting strongly with the adjacent colors. The sides of the prothorax are gray, and there is a pair of rather definite oblique gray marks just behind the front outer angle of each wing-cover. The beetle is slow and lumbering in its movements, and when disturbed drops to the ground like a curculio, without attempting to fly. It feeds upon the cambium layer of the younger branches, which it reaches by puncturing the bark with its snout. It lays its eggs in the older bark, mainly of branches from two to four years old. This the female does by first eating downward into the bark by means of the jaws at the tip of her snout, taking half an hour or more to hollow out a cavity in which the egg is concealed. She then turns end for end, and leaves an egg in the chamber thus made, and presently moves away to repeat the process at another point.

The young hatch mainly in August and September, penetrate at once to the cambium layer, and hibernate there while most of them are still very small. The following spring they continue to work in the cambium until nearly ready for pupation, when they enter older wood.

The dependence of the beetle for food upon the bark of the tree which it infests has suggested the use of poisons for its destruction, and some tests made at the New York Agricultural Experiment Station show that the ordinary arsenical poisons applied as a spray will destroy it. Arsenate of lead is the best of these for the purpose, because of its adhesive quality. Trees to be protected should be thoroly sprayed at intervals of about a fortnight, beginning



Fig. 47. Poplar and Willow Borer,
Crypho-hynchus lapathi, adult. Length,
about one-fourth inch.

with the middle of July and continuing thru August. Moderately infested trees may be saved by cutting out the grubs and covering the wound with tar. Badly infested trees should be taken out and burned, either during the winter or before July 1 of the following season. Nursery trees infested by this insect should be unhesitatingly destroyed, since they are far worse than worthless, and are the principal means of conveying the species to places not previously infested by it.

THE DOGWOOD TWIG-GIRDLER

(*Oberea tripunctata* Swederus)

Among the insects whose nice and elaborate instincts connected with the placing of their eggs are the wonder of entomologists, we must class the twig-girdlers, for their careful preliminary operations are such as to suggest a knowledge of vegetable physiology and a prevision of the possible difficulties in the way of the development of their young certainly quite beyond the powers of insect intelligence, and an unsolved puzzle if regarded as a product

of natural selection. The twig-girdler of the dogwood is an example.

This is a small, cylindrical beetle (Fig. 48), about half an inch long and less than an eighth of an inch in diameter, which prepares a chosen twig for the reception of the egg by first cutting a groove around it a few inches from its tip in such a way that the twig



Fig 48. Dogwood Twig-girdler, *Oberea tripunctata*, adult. About 5 times natural size.



Fig. 49. Cornus twig girdled by Dogwood Twig-girdler, *Oberea tripunctata*, and part enlarged, showing egg in position.

presently breaks off at this point, and afterwards making a second girdle, not so deep as the first, and from two to four inches farther back. (Fig. 49.) It then makes two parallel cuts, about half an inch long, lengthwise thru the bark between the two girdling incisions, and at the proximal end of these makes a short transverse slit in a way to form an angular flap, beneath which it pushes its egg. The effect of all this surgery must be to stop the growth of that part of the branch operated on, and to check the flow of sap to the section in which the egg is laid.

These operations are distributed, in northern Illinois, over the month between the middle of June and the middle of July. The eggs hatch within a week or ten days, and the young larvæ penetrate the twig, burrowing downwards towards its point of attachment, and making holes to the surface at intervals thru which to discharge their excrement. After a time the larva cuts off, from within, the part of the twig thru which it has made its way, and plugs the open end of the burrow with coarse bits of frass. It occasionally repeats this plugging, pursuing its way until winter overtakes it, and pupating within its burrow from the middle to the latter part of the following May, first, however, commonly cutting off the branch obliquely and plugging the cavity a little beyond its pupal cell. (Fig. 50, 51.) The adult emerges during the latter



Fig. 50. Dogwood Twig girdler, *Oberea tripunctata*, larva. About 4 times natural size.

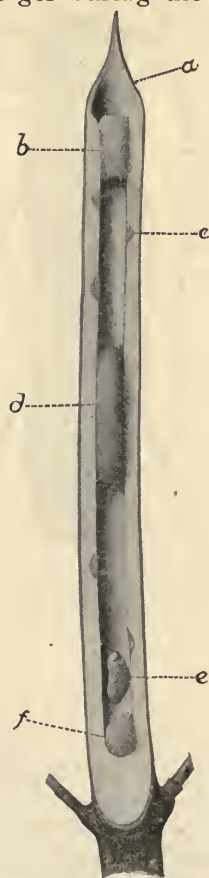


Fig. 51. Cornus twig with burrow of Dogwood Twig-girdler, *Oberea tripunctata*: a, end obliquely cut off by larva; b, f, plugs of frass; c, openings made by larva and plugged up later; d, cocoon of ichneumonid parasite; e, remains of parasitized *Oberea* larva.

half of June, eats its way thru this terminal twig, and feeds during its short life on the leaves of the infested tree, making oval holes thru the leaves along the course of the veins. (Fig. 53.)

The presence of this borer is commonly first betrayed by a withering of the leaves at the tip of the girdled shoots. It is a rather common pest in the Chicago parks, where it has often been abundant enough on the red-osier dogwood (*Cornus sanguinea*) to be decidedly injurious. Like the other small twig-girdlers, this species can best be destroyed by cutting off and destroying the affected



Fig. 52. Dogwood Twig-girdler, *Oberea tripunctata*, pupa. About $2\frac{1}{2}$ times natural size.

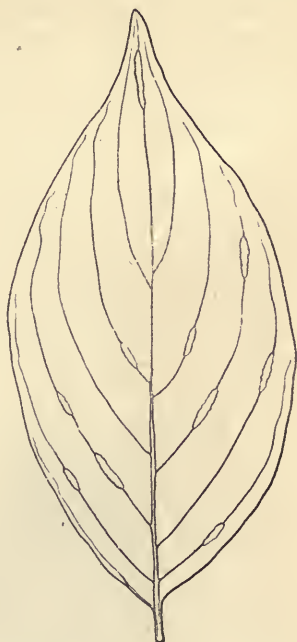


Fig. 53. *Cornus* leaf injured by feeding of adult Dogwood Twig-girdler, *Oberea tripunctata*.

branches at a time when they are certain to contain the borer; that is to say, in this case, in any month except June and July.

The various species of this genus have been so imperfectly distinguished that a specific description of this will not be attempted here; but the reader is referred to the illustrations for its general characters. Its larva is much subject to destruction by parasites; and a characteristic parasitic species has been repeatedly bred by us from infested twigs.

THE LOCUST BORER
(*Cyrtene robiniae* Forst.)

A great obstacle to the growth of the common black locust as a timber tree in Illinois has been the work of a borer which infests this tree only, multiplying year after year in a locust grove until it destroys every tree. It was a common practice in the early settlement of the northern part of the state for the farmers to plant a grove of locusts, with a view especially to a supply of fence-posts. These groves were, however, all destroyed by this borer during the middle part of the nineteenth century, and the planting of this tree was universally abandoned at that time. Of course, with the disappearance of the tree the borer likewise disappeared, and the growing of the locust is now again possible if due precautions be taken against its destruction by this insect. Fortunately, the recent work of Dr. A. D. Hopkins, in charge of forest insect investigations for the United States Department of Agriculture, has made it perfectly feasible to grow locusts with little or no loss from this cause, and the following account is mainly taken from his publications on this subject.

The first evidence of attack by this borer in spring is a fine brownish dust and an oozing of sap from the bark. Later, gumlike exudations appear on the injured spots, and quantities of yellowish



Fig. 54. Locust Borer, *Cyrtene robiniae*, pupa: a, front view b, back view. Enlarged as indicated. (U. S. Dept. of Agriculture.)

dust lodge in the forks of the tree or branches, and in the loose bark on the trunk and around its base. Badly infested trees show a dwarfed, faded, or sickly foliage about the middle of May, and many of the leaf buds fail to open. The author of this injury is a whitish, thick-bodied, distinctly segmented, seemingly footless grub, nearly an inch long when full grown, with small head, and only a pair of minute feet on the next segment behind. It hatches from eggs laid in crevices of the bark from August to October. The young borers are still very small when the winter overtakes them, and they hibernate in small cavities made by them in the outer bark of the trunk and branches. They commence operations when the sap of the tree begins to flow the following spring, and presently penetrate the wood, burrowing actively about until July or August, in central Illinois, when they begin to change to the pupa (Fig. 54), to emerge about a month later in the beetle stage (Fig. 55).



Fig. 55. Locust Borer, *Cyllene robiniae*: a, male; b, female. Enlarged as indicated. (U. S. Dept. of Agriculture.)

The adult is a very showy, elongate, brown beetle, five-eighths to three-fourths of an inch in length, conspicuously marked with three straight bands of bright yellow across the thorax and five broken or irregular bands of the same color across the wing-covers. There is also a bright yellow patch on the upper side of the tip of the abdomen. The beetles are to be found in September, and occasionally in early October, on locust-trees, and on various species of golden-rod, upon the flowers of which they feed. Now and then a speci-

men may survive the winter and be taken abroad in April, or even in May.

From the foregoing statements it is evident that the time of cutting trees, whether to thin the grove or for commercial use, is an important item in the control of this beetle. All such cutting should be done between October 1 and April 1, care being taken that all trees showing the presence of the borer are selected for removal. The bark should then be taken off, and the brush and rubbish should be burned. Simply to kill the larvæ and borers in badly infested and damaged trees, these should be cut and destroyed in May and June, when their condition can be readily detected; but the work should be completed by the time the flowers have all fallen from the trees, as otherwise the borers may mature and escape. Where the beetles are abundant on the goldenrod, they may be attracted and killed, according to Dr. A. D. Hopkins, by smearing molasses poisoned with arsenic upon the trees, due account being taken of the fact that honey-bees are liable to destruction by this poison, and that it should not be used where these are kept. Unsuccessful experiments were made by one of my assistants, Mr. W. P. Flint, in 1910, with a mixture of sugar and vinegar, and another of sugar and alcohol. Altho attractive to a variety of other insects, the beetles of the locust-borer paid no attention to them. Tanglefoot, on the other hand, placed on the trees September 16, when the beetles were freely running about mating and laying their eggs, disabled the beetles and put a stop to their operations.

Highly useful directions for the management of locust plantations in a way to prevent injury by borers, are contained in Bulletin 58 of the Bureau of Entomology of the U. S. Department of Agriculture, printed in 1910.

THE OAK TWIG-PRUNER (*Elaphidion villosum* Fabr.)

Among the more striking and curious kinds of insect injury to trees are those which take the form of amputation of twigs and small branches during the growing season—an injury which seems purposeless and excessive until one sees just how it benefits the author of it.

The oak twig-pruner (Fig. 56) is one of the best known American insects with this habit of injury, affecting, as it does, a large variety of trees and shrubs, and injuring most frequently some of the commonest and most useful species. It is best known, perhaps, for its work on oaks, hickories, and maples, altho it has been reported to attack also apple, peach, pear, plum, quince, locust, redbud, sumach, Osage orange, fir, grape, and climbing bittersweet. In Illinois we have bred it from oaks, hickories, persimmon, and peach,

and have found it thruout the state. In parts of Michigan, peach-trees have sometimes been nearly destroyed by it, and an equally serious injury has been done by it in New York to pears. In Illinois we once found it at Effingham cutting off young apples-trees from



Fig. 56. Oak Twig-pruner, *Elaphidion villosus*, larva.
About 5 times natural size.

one to two feet above the ground; and Dr. F. W. Goding reported it, in 1884, as doing great damage to hickory and elm at Ancona, in Livingston county. In Pennsylvania, oak forests have been so infested by it that carloads of the twigs might have been collected from under the trees; and in Connecticut, hickories have been so thoroly pruned that a barrel of twigs and branches have fallen from a single tree.

The injury done by this insect is not, however, so severe as it looks. It may affect considerably the appearance of young trees, by deforming their top; but large trees are generally little harmed by the pruning they receive, and the littering of lawns with amputated twigs is at most an annoyance merely. The girdled twigs and branches may vary in length from a few inches to several feet, but Dr. Fitch mentions one that was ten feet long and over an inch thick. Commonly, however, they are a quarter of an inch or less in diameter, and vary from two to six inches in length. Occasionally a single one will contain two larvæ, the burrows then running down each side of the twig. Fallen limbs, if not disposed of, may serve, as Chittenden has said, as breeding places for various kinds of injurious borers, which may come out from them to attack and injure living trees.

The method of the pruner's work is such that a fallen twig is seen to have been hollowed out centrally—a large part of its interior often being eaten away—and plugged with sawdust, and its larger end has been gnawed off from within, having a cut surface as smooth as if made by a chisel.

The adult twig-pruner is a rather slender, dark brown beetle (Fig. 57) from a half to three-quarters of an inch in length, sparsely covered with coarse white or yellowish hairs which show a tendency to collect in irregular clumps or spots. The edge of the tip of each wing-cover is concave between two stout sharp spines or teeth, of which the outer is usually the larger. The female lays

her eggs in the smaller twigs of living trees, most commonly in July. The young larva first eats out the wood under the bark in the direction of the grain, packing its burrow behind it with its castings, and working towards the base of the twig. Later it cuts holes in the bark thru which these castings are rejected, and then follows the center of the twig, making a channel more or less oval in cross-section, corresponding to its own shape. When it has reached its growth it begins to gnaw, from within, a circular groove, deepening this until the twig or branch is so weakened at this



Fig. 57. Oak Twig-pruner, *Elaphidion villosum*, adult. About 5 times natural size.

point that the wind readily breaks it off, usually carrying the insect with it. Occasionally, however, the larva is left in its burrow on the tree and finishes its transformations there. The value of this operation to the pruner would seem to be a preparation for the exit of the beetle, which originates within the burrow, but which has not jaws of a sufficient strength to enable it to gnaw its way out thru the wood inclosing it. This explanation, given by Chittenden, seems at least to be the most reasonable among several that have been proposed to account for this curious habit. After the twig has been cut off the larva within it plugs up the severed end, changes to the pupa, and later to the beetle, coming out as an adult the following summer.

Published accounts disagree as to the length of the life cycle of this species. It seems to be a single year under the most favorable conditions, but capable of being lengthened to two or even three years, particularly if the branch dies before the larva is full grown.

As nearly all the borers pass the winter in the fallen twigs, it easily follows that their injuries may be readily arrested by gathering these up and burning them in winter or in spring. This effective measure is so simple and so easily applied that no other seems necessary.

THE BRONZE BIRCH-BORER

(*Agrilus anxius* Gory)

This insect is a deadly pest of the birches, especially of the beautiful and popular white birch, which it is quite capable of exterminating locally if its presence is not early detected and if prompt measures are not then taken for its destruction. As an infested tree is not likely to last more than two or three years, the necessity of energetic measures is obvious. Unfortunately, this insect does not usually make conspicuous local marks of the injury it is doing, and the earliest sign of its presence is often the death of one or more branches in the top of the tree. If a birch is seen to be dying at the top it should at once be examined for evidences of the presence of this borer, since in some cases this condition may be due to drought or other general causes. If the bronze borer be the cause, the fact may be ascertained by lifting the bark from dead branches which are not yet dry, or from the more unhealthy looking spots on the living parts of the tree. If the insect be present, its tortuous or zigzag burrows will be noticed, and further search will disclose the borer itself in one or more of its stages of larva, pupa, or adult. Sometimes, indeed, its presence is shown by a ridged appearance of the bark, the ridges running crosswise of the branches or in a more or less spiral direction. Peculiar rusty or reddish spots may also be seen on the larger branches or on the trunk where the bark has been undermined by the interlacing burrows of the borer. Often branches weakened by the borers and by consequent decay of the wood, break at the point of injury, either hanging down or falling from the tree. This appearance is rather characteristic of the work of the borers, and may serve to distinguish an infested tree from a "stag head," due to drouth.

In its destructive stage this insect is a small, flattened, footless, creamy white grub about three-fourths of an inch long when full grown, with dark mouth-parts and a small head which is partly drawn back into the broad, flat, pale brownish, first segment of the body. At the opposite end is a pair of minute forceps-like spines, brown and hornlike, with two teeth on the inner edge of each. In this larval condition the borer may be found in its burrows beneath

the bark at any time during fall, winter, and early spring. If the tree has been long infested, the bark is usually perforated by small roughly semicircular holes about twice the diameter of the head of an ordinary pin. (Fig. 58.) These holes are made by the beetles when they come out in May and June for their brief life in the open air.

The beetle (Fig. 59) is a hard, small, bronze-green or violet insect, varying somewhat in size, but approximately half an inch long or a little less. It is shining but minutely punctured under a glass,

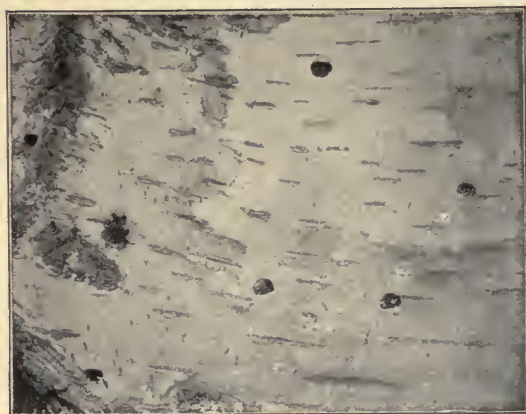


Fig. 58. Exit holes of the Bronze Birch-borer, *Agrilus anxius*, in the bark. Natural size. (Cornell Experiment Station.)



Fig. 59. Bronze Birch-borer, *Agrilus anxius*, adult. About 5 times natural size.

with the sides nearly parallel, tapering conspicuously behind to a blunt tip, notched where the rounded ends of the wing-covers come together.

Altho most notorious for its injury to the white birch, especially the cut-leaved variety, it infests all the birches. It is the most destructive enemy of these trees in the Chicago parks, thru which it is generally distributed. It is especially dangerous because there is no means of destroying it which does not involve also the destruction of the infested tree. It is a saddening conclusion which is forced upon the owner of a beautiful birch infested by this borer, that the tree is doomed, and that the only means of saving other trees in its neighborhood is to cut it close to the ground in winter or spring, as early as the first of May, and to burn it, trunk and branches, before the beetles can emerge to lay their eggs elsewhere.

The larvæ hatch in June, and possibly also in July, from eggs laid in crevices in the rougher places of the bark. They bore thru the bark at once and begin to mine in the sapwood, sometimes dipping inward to the older wood or even penetrating to the center of a small branch. The irregular mine is always packed with the castings of the grub, and increases in diameter, of course, as the latter grows, measuring at the largest about an eighth of an inch across. Here the borer lives in the larval state until the latter part of the following April or early May, when it begins to transform within its burrow to the pupa stage, and within another month to the beetle. This escapes from the tree from the middle to the last of June in northern Illinois, by gnawing through the bark, flies abroad to feed on the leaves of trees, and soon pairs and lays its eggs. Curiously, it seems to feed but little on the birch, preferring the leaves of poplar, willow, and elm to those of its native tree. There is, indeed, some evidence that it infests the willow, producing gall-like swellings on the twigs, but the identity of the species to which this injury is referred is not positively settled.

Trees of large size are often killed by this borer within three or four years after they first become infested, and few live more than two or three years after the top branches begin to die. The necessity of prompt action is thus manifest, and as the time of the escape of the beetles varies with latitude and the weather of the year, it is best to take time by the forelock and to destroy the infested tree as early at least as April 1. Then one may be sure that nothing can have escaped from it to extend the injury.

This insect is not now known to range beyond Virginia to the south or Illinois to the west, but it very likely occurs wherever birches are grown. We have lately found it (1910) outside Chicago, in Elgin, Rock Island, Moline, and Bloomington, abundant enough in all these places to be decidedly injurious to the birches. It has been quite fully discussed by Professor M. V. Slingerland in Bulletin 234 of the Cornell University Agricultural Experiment Station, published in January, 1906, and briefer accounts may be found in the report of Dr. E. P. Felt, State Entomologist of New York, in "Insects Affecting Park and Woodland Trees" (page 284), published in 1905; in an article by F. H. Chittenden published in 1898 in Bulletin 18, new series, of the Division of Entomology, U. S. Department of Agriculture; and in a paper on "A Disease of the White Birch," by John Larsen, printed by the Michigan Academy of Science in its third report (1902).

THE SCURFY SCALE (*Chionaspis furfura* Fitch)

The so-called scurfy scale is the commonest of all scale insects thruout the state on shade and orchard trees. The female scale

(Fig. 60, *a*, *c*) is about a tenth of an inch in length, irregularly oval, with a yellowish point at one end, and but very slightly convex. It is nearly white when fresh, but becomes gray or sooty with exposure. The scale of the male insect (Fig. 60, *b*, *d*) is

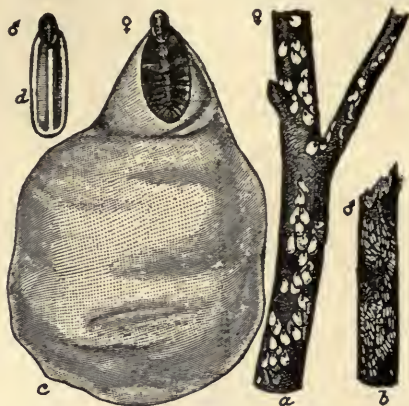


Fig. 60. Scurfy Scale, *Chionaspis furfura*:
a, *b*, female and male scales, natural size; *c*,
d, same, enlarged.

narrow, with sub-parallel sides, and is marked by three longitudinal ridges. The species may be readily recognized in winter by the fact that under each female scale will be found a small mass of minute, purplish eggs. The young appear to the naked eye as active, snowy whitish or reddish specks. These insects are often so abundant on an infested tree as to give a scurfy appearance to the trunk and limbs.

This scale insect is a general feeder, but is especially common on rosaceous plants. It also heavily infests the elm, which seems the most susceptible to its injuries of any of our ordinary shade trees. The red-twigged dogwood is often incrustated by it, and the mountain ash, hawthorn, pear, and currant are sometimes attacked. The scurfy scale winters in the egg, and hatches, with us, during the latter half of May—earlier or later according to the season and the part of the state. In central and southern Illinois eggs are laid for a second generation, the date of which, however, has not been accurately determined. Altho this can not be classed among the more destructive scale insects, it is nevertheless injurious where especially abundant, checking the growth and diminishing the vitality of the infested tree or shrub in a way to make it less presentable and more susceptible to the attacks of other insects and of disease.

Two insecticide sprays are fairly effective against this insect; one a winter spray of lime and sulphur, prepared and administered as described in detail under the article concerning the San Jose scale, and the other a summer spray of kerosene emulsion, a formula

for the preparation of which is given under the cottony maple scale. The lime-sulphur mixture should be applied as late in the winter as practicable, best just before the opening of the leaves in spring. The kerosene emulsion must be applied immediately after the hatching process is virtually complete, a point which can only be determined accurately by careful observation. If the young are allowed to live too long they become covered and protected, after fixing themselves, by a waxy scale which the emulsion will not penetrate. It should be applied in a strength to contain ten percent of kerosene. Dr. James Fletcher, Dominion Entomologist, Canada, recommended spraying infested trees with a whitewash made by slaking a pound of lime to the gallon of water, one such application to be made in fall as soon as the leaves have fallen, and a second immediately after the first has dried. This is said to loosen the hibernating scales, which subsequently fall from the tree with the dried whitewash.

THE OYSTER-SHELL SCALE

(*Lepidosaphes ulmi* Linn.)

The oyster-shell scale is among the more conspicuous and easily recognized of the smaller scale insects of our trees and shrubs, the

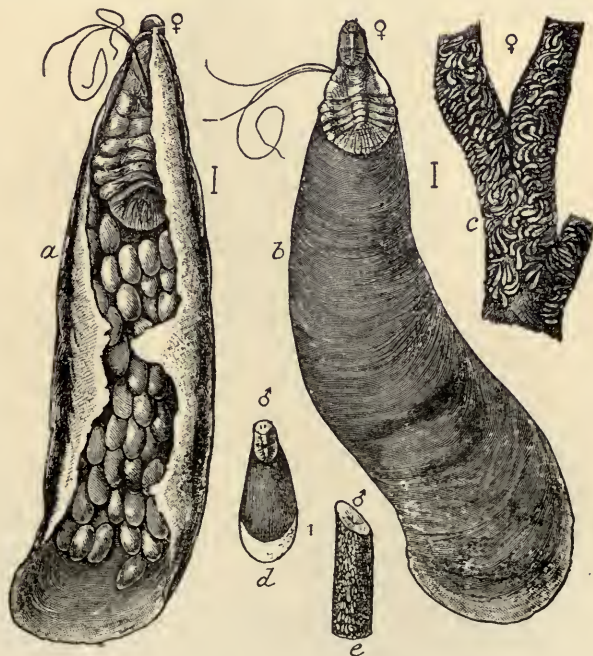


Fig. 61. Oyster-shell Scale, *Lepidosaphes ulmi*: a, female scale, under side, showing insect and its eggs within; b, same, from above; c, same, natural size; d, e, male scale, enlarged and natural size.

common name suggesting its most conspicuous character. It has, indeed, the convex, elongate, and more or less bent and irregular form of an oyster shell. The female scales (Fig. 61, *a*, *b*, *c*) are about an eighth of an inch long, the male scales (Fig. 61, *d*, *e*) smaller, with a little hinge or flap behind, thru which the winged males escape when mature. The scale is usually brown to dark brown in color, tho occasionally bleached to gray by exposure to the winter weather. The eggs of the species hatch in Illinois shortly after the time the apple blossoms fall. Each female scale has during the winter from fifty to a hundred and twenty-five pale yellowish eggs beneath it, from which the young emerge during the latter part of May or the first of June. A second generation occurs in central and southern Illinois early in July. The young are able, at first, to crawl about somewhat actively, and it is principally by this means that the species is distributed, altho it may be conveyed to distant points upon infested nursery stock. The scale insect is both larger and more injurious than the scurfy scale, and infests also a larger variety of trees and shrubs. Elm, poplar, willow, horse-chestnut, lilac, red-twigged dogwood, and currant are among those most frequently and seriously injured.

The treatment for this scale is identical with that described in the article for the scurfy scale, just preceding.

THE SAN JOSE SCALE

(*Aspidiotus perniciosus* Comst.)

This notorious and destructive pest is much less injurious to ornamental vegetation than to fruit trees and shrubs, but is nevertheless decidedly harmful to several of the former, particularly to those belonging to the family of roses. It is also very injurious to the mountain ash, but the Japanese quince (*Pyrus japonica*) is the common shrub most likely to betray its presence.

It is a circular, grayish or yellowish, scale insect about one-sixteenth of an inch in diameter, but slightly convex, and marked by a central nipple and one or two surrounding circular ridges. It is an inconspicuous object, but is recognizable by the appearance which it gives to a badly infested bark (Fig. 62), which it covers with dark gray patches of a continuous grayish crust, which exudes, when crushed with the finger-nail, an oily, yellowish substance due to the pressure on the living insects under the scales. The bark of a tree but sparsely infested may be seen, on close examination, to be irregularly specked with small circular granules which give it an unhealthy look. The surface immediately beneath the living scales often shows a reddish discoloration; and on the leaves and green twigs are more conspicuous red blotches which surround the scales.

The largest scales are about the size of the head of an ordinary pin, and the smallest ones are mere specks on the twig.

This insect passes the winter partly grown, reaches its full size in spring, and begins to bring forth its living young about the first of June, in average years, in the central part of Illinois. These may be seen as minute yellow specks wandering over the surface in search of a suitable place to establish themselves. This period of active life is often limited to a few hours, and at most to one or two days. Three or four generations are bred in a single season.

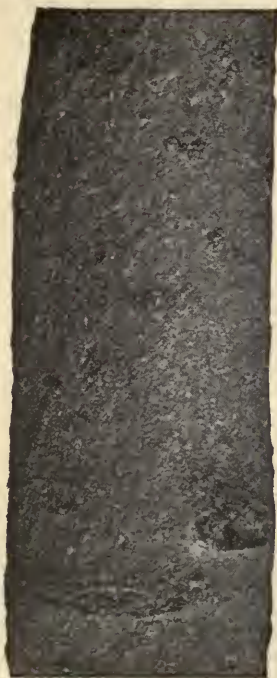


FIG. 62. San Jose Scale, *Aspidiotus perniciosus*. Natural size. (Connecticut Experiment Station.)

It has been found commonly infesting and often injuring more than seventy trees and shrubs, and occasionally nearly as many more. The commoner kinds coming under the former list are some of the dogwoods, the hawthorns (*Crataegus*), the quinces, the poplars, the cherries and pears, currants and gooseberries, roses, willows, mountain ash, snowberry, lilac, basswood, Osage orange, and the elms. Those less seriously infested are the maples, horse-chestnut, Virginia creeper, the birches, chestnut, catalpa, hackberry, the flowering and other dogwoods, the persimmon, *Forsythia*, white ash,

honey-locust, *Althea*, pecan, black walnut, mountain laurel, honey-suckle, mulberry, white spruce, sour cherry, sumach, smoke-bush, locust, raspberry and the blackberry, elder, sassafras, various species of *Spiraea*, arbor-vitæ, *Viburnum*, and grape. Popular species not infested by it are *Ailanthus* or tree of heaven, papaw, spice-bush, barberry, trumpet-vine, the hornbeams, cedar, bittersweet, buttonbush, Judas-tree, fringe-tree, pepperbush, leatherwood, ginkgo, Kentucky coffee-tree, witch-hazel, English ivy, hickories except the pecan, hydrangeas, yellow jasmine, butternut, juniper, larches, sweet gum, tulip-tree, matrimony-vine, wax myrtle, black gum, syringa, pine, sycamore, the oaks, the rhododendrons, bald cypress, trumpet-creeper, blueberry, hemlock, *Wistaria*, and prickly ash. The last list is especially important in Illinois, thruout which the San Jose scale is certain ultimately to become generally distributed, because it includes a large and varied list of ornamentals from which selections may be made without the risk of loss or injury by this most destructive pest.

The San Jose scale is conveyed to distant points mainly by the trade in nursery stock, and otherwise it spreads only by means of the minute crawling young. Its means of dispersal are so slight that it tends to concentrate upon any tree infested until the latter becomes completely covered by it, a fact which, taken together with its numerous generations, its rapid rate of multiplication, and its freedom from parasites capable of overcoming it, make it the dangerous enemy which it has become.

The San Jose scale can be destroyed by the winter use of one of the lime and sulphur mixtures, which may either be purchased ready-made in condition for use by dilution only, or may be brought into solution by boiling the raw materials together according to the following directions.

Materials: 15 pounds of lime, 15 pounds of sulphur, and 50 gallons of fairly soft water. For 50 gallons of the spray, heat 12 gallons of water in a 40-gallon iron kettle, mixing, in the meantime, in a separate vessel, 15 pounds of sulphur with enough water to form a thin paste. Add this sulphur to the water in the kettle and bring the mixture to a temperature just below boiling. Then add 15 pounds of best lump lime, keeping cold water at hand to use as the mixture threatens to boil over. After the lime is fully slaked, boil for 40 minutes, with almost constant stirring. Then strain into a 50-gallon spray-tank and fill with water, which had better be warm, although cold water will do. To prepare 100 gallons of the spray at a time, heat 20 gallons of water in the 40-gallon kettle, add 30 pounds of sulphur—previously reduced to a thin paste with water—and to this put 30 pounds of lime. Boil as before, and dilute to 100 gallons.

If a supply of steam is available for cooking the mixture, this will be found a much more convenient source of heat. The cooking is then done in barrels or other vessels, from which the fluid is strained into the spray-tank. The disturbance caused by the introduction of steam makes stirring unnecessary. When cooked with steam the mixture does not ordinarily become so dark as when boiled over a fire, but the insecticide effect is nevertheless the same.

PUTNAM'S SCALE
(*Aspidiotus ancylus* Putnam)

This is a circular or oval, dark gray or black, scale insect, about one-twelfth of an inch in diameter, with a brick-red point at one side of the center. It closely resembles the San Jose scale in general appearance, but does not present the conspicuous ring and nipple structure of the latter, altho the young have usually a nipple and a rather indefinite ring.

It passes the winter but partly grown, but differs from the San Jose scale in the fact that it reproduces by means of eggs laid in late spring or early summer. There is but one generation in a season.

It has been found on elm, willow, oak, hemlock, mountain ash, *Ilex*, white birch, *Prunus*, ash, beech, hackberry, linden, maple, Osage orange, and water-locust. It is rarely injurious enough to require special attention.

THE WALNUT OR WILLOW SCALE
(*Aspidiotus juglans-regiae* Comst.)

This species, altho common on a number of shrubs and shade trees, is of little importance except on the willow, to which it is a veritable pest. It is easily distinguished from other scales of the San Jose relationship by its relatively large size, its diameter being 3 mm., or an eighth of an inch. The female scale (Fig. 63, *a*, *e*,) is

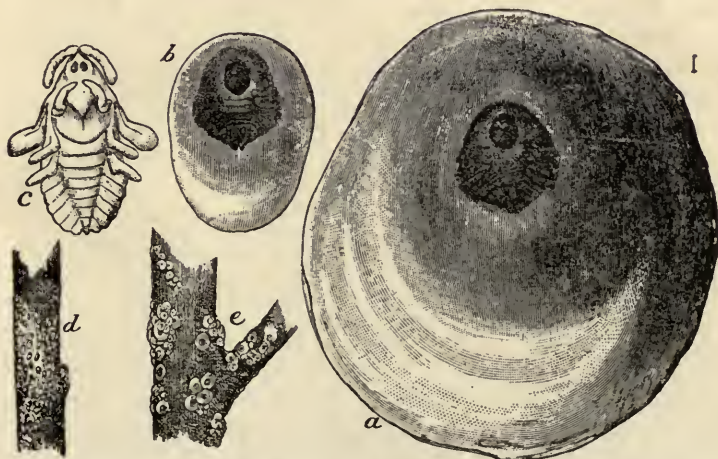


Fig. 63. Walnut Scale, *Aspidiotus juglans-regiae*: *a*, *b* female and male scales, enlarged; *c*, male pupa; *d*, *e*, male and female scales, natural size.

circular, flat, with a prominent pink or reddish point at one side of the center. The male scale (Fig. 63, *b*, *d*) is elongated, with a corresponding point near one end. The female passes the winter as an adult, and lays her eggs in early spring.

Treatment the same as that for the scurfy scale.

THE COTTONY MAPLE SCALE

(Pulvinaria vitis Linn.)

The cottony maple scale (Fig. 64) is one of the best known scale insects because it heavily infests several very common shade trees, and because the cottony masses beneath the body of the adult female in early summer make it a very conspicuous object. These large white masses are a deposit of waxy threads within which are the minute, oval, pale yellowish eggs.

The history of this insect in Illinois since 1867 exhibits successive periods of abundance and of scarcity, each averaging about four or five years for the state as a whole. That is, thruout some considerable part of the state, and often over most of it, the maple scale has been injuriously abundant once in eight or ten years, and its period of abundance has lasted, as a rule, about half this time. In any given locality, however, it has usually been injurious for a much shorter time, often for not more than one or two years. The cessation of its injuries and its virtual disappearance from the trees infested by it have seemingly been due almost wholly to the agency of its insect enemies.

The soft maple (*Acer saccharinum*) is the tree most generally and heavily infested by this insect. The hard maples, on the other hand, are infested but slightly if at all. The box-elder is also greatly subject to injury, and next to this, perhaps, the linden or basswood. Among the other trees and woody plants often more or less injured, are the elm, honey-locust, black locust, black walnut, sumac, willow, poplar, beech, hawthorn, bittersweet, grape-vine, and Virginia creeper. We have found mature egg-laying females on the horse-chestnut, honeysuckle, dogwood, trumpet-creeper, mulberry, snowberry, smoke-tree, *Spiraea*, false syringa (*Philadelphus*), and *Wistaria*. Oak, ash, and catalpa are not infested in northern Illinois, but injury to oaks is reported from Georgia. The pear is said to be most liable to injury among the fruit trees, and apple, plum, and peach are sometimes infested. Serious damage to fruit trees is, however, very unlikely. The migrating young, which are often washed from trees by rain, or blown off in considerable numbers, may maintain themselves for a time on a great variety of woody and herbaceous plants, those on the latter, of course, perishing with the advent of frosts.

In early summer this scale, when very abundant, coats the under side of heavily infested limbs with a thick layer of cotton-like waxy masses, each projecting from beneath a brown cap or scale—the flat body of the mature female. This “cotton” is secreted and the eggs are deposited within it in late May or early June in the latitude of central Illinois, but usually one or two weeks later in the Chicago district.

Something over 3,000 eggs are usually laid by each female, the number ranging, in our counts, from 2,856 to 3,863, with an average



Fig. 64. A Soft maple twig badly infested with adults of the Cottony Maple Scale, *Pulvinaria vitis*. About natural size.

of 3,410. In central Illinois the eggs ordinarily hatch in June, and in the northeastern part of the state in early July, or later if the weather of the time is unfavorable. Virtually all are hatched, as a rule, by the end of July.

When first hatched the six-legged young (Fig. 65, *a, e, f*) move slowly about as creeping yellowish specks about twice as long as wide. They soon settle upon the leaves, mostly upon the under side

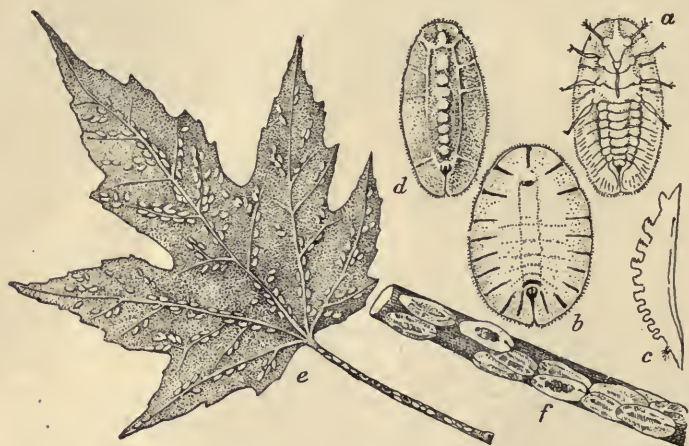


Fig. 65. Cottony Maple Scale, *Pulvinaria vitis*, immature stages: *a*, newly hatched young, under side; *b, c*, young female, top and side views; *d*, young male; *e, f*, young on leaf and leaf stem. Natural size shown in *a*.

along the veins, but a considerable percentage also on the upper surface. Soon after settling down, a thin waxy layer forms on the back, and in about three weeks the insect has virtually doubled in size. As they increase in size the male and female scales become distinguishable (Fig. 65, *b, c, d*) by the fact that the former are comparatively narrow and more convex. From these the winged males (Fig. 66, *a, b, c*) emerge to fertilize the stationary females in August and September, perishing soon thereafter. In autumn the young females migrate from the leaves, which are about to fall, to the twigs, upon which they pass the winter and, indeed, the remainder of their lives. In spring the female scale (Fig. 67) is elliptical, convex on the back, with a low, rounded, median ridge. It is pale greenish or whitish yellow, marked with black or dark brown. When full grown, about the middle of May, it is 4 to 6 mm. long and 3 to 4.5 mm. wide. Its body is at first closely applied to the surface of the twig, but with the development of the eggs beneath it the abdomen is gradually raised from the bark to an angle of forty-five degrees or more.

It is usually difficult to say whether trees infested by this insect should receive special treatment, or whether they may be safely left

to the natural course of events. The cottony maple scale is extremely subject to parasites and attacks of other insect enemies, particularly to the black hemispherical ladybugs and their larvæ, the latter of which feed upon the egg masses in spring and summer. With an extraordinary abundance of the scale insects themselves

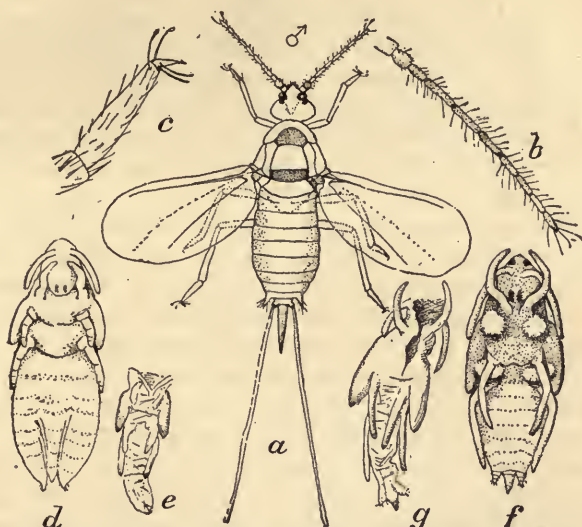


Fig. 66. Male of Cottony Maple Scale, *Pulvinaria vitis*: a, adult; b, c, antenna and leg enlarged; d, e, second stage of pupa and its cast skin; f, g, true pupa and its cast skin. All greatly enlarged.

these insect enemies improve the opportunity for unusual multiplication in a way to produce a greater number than can possibly be maintained permanently by the scale insects. A check is thus put upon the increase of the latter which, within a few months, may reduce them to insignificance. The consequence is an irregular peri-



Fig. 67. Cottony Maple Scale, *Pulvinaria vitis*. Adult female in spring, just before the formation of the cottony egg sac. Enlarged.

odicity in the numbers of the cottony maple scale such that two years of injurious abundance rarely succeed each other in the same place. Nevertheless, where trees are evidently suffering from the scale attack it is always prudent, and often necessary, to take artificial measures of protection.

As the newly hatched young are especially susceptible to the petroleum insecticides, which act by contact, a definite knowledge of the hatching period has an important practical value. In central Illinois this period extends approximately from June 15 to July 20. In and about Chicago it commonly begins about two weeks later, and continues for a period of three weeks, this retardation being apparently due to the higher latitude and to the neighborhood of Lake Michigan. The period varies, in short, as to its beginning time, with the advancement of the season, and once begun, the rapidity of the hatching will depend, other things being equal, on the warmth of the weather. It is also influenced locally by the amount of foliage on the trees, the eggs hatching later and more slowly in a dense tree-top than in one more open to the sun.

The only insecticides available against these insects are those which kill by contact, and of these the kerosene mixtures have thus far been found the most useful. Even these can be applied only to the young scales shortly after they hatch from the egg, no insecticide treatment being available for the destruction of the large and conspicuous females upon the twigs in May and June. The common kerosene emulsion, made by thoroly and intimately mixing kerosene with one-third of its volume of a strong soapsuds, is a satisfactory spray when diluted to contain ten percent of kerosene for summer use, and sixteen to eighteen percent is used in winter. As a summer spray this emulsion must be used twice in succession, once when about half the eggs are hatched and again about ten days thereafter. A single treatment in winter is about the equivalent in practical effect of two such summer sprays. Large trees in a sandy soil, and especially those in more or less unthrifty condition, should be guarded against possible injury to the roots from the dripping of the kerosene spray, or from that part of it which may run down the trunk and so reach the earth. For this purpose it would be well to cover the ground before spraying with a thin layer of straw, packed closely around the base of the trunk, and later to gather this up and carry it away.

The cost of materials for large trees will average approximately fifteen cents a gallon for the summer spray, and about twice as much for the winter strength.

Kerosene emulsion is made as follows: Dissolve one pound of common soap, or half a pound of whale-oil soap, in one gallon of water by boiling, remove from the fire, and add two gallons of kerosene. Then with a spray pump force the mixture back into itself for about five minutes, or until it presents the appearance of a thick cream and no longer separates on standing. This is the undiluted emulsion. For a mixture containing ten percent of kerosene, add seventeen gallons of water to the three gallons thus prepared. For

an eighteen-percent kerosene emulsion, add eight gallons of water to the stock emulsion. Soft water is to be preferred.

The following tables will show the effects of kerosene sprays as applied by us in 1905 and 1906.

SUMMER SPRAY

Treatment		No. of trees	Leaves examined	Scales examined	Percent killed by spray
Insecticide	Part of hatching period				
10 percent kerosene	Beginning	1	75	48,789	33
10 percent kerosene	Middle	1	50	19,425	64
10 percent kerosene	End	3	150	281,271	68
10 percent kerosene	Middle and end	1	100	57,179	82

WINTER SPRAY

When sprayed	Percent of kerosene	Date of counting	Scales counted	Percent killed
December 26 to January 5 (once)	19	Feb. 1	12,703	86
January 11 to 13 (once)	20	Feb. 1-2	23,061	91
January 11 to 13 and March 30 (twice)	19-24	June 10	48,395	91



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